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**AERONAUTICS**

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics.*

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For related information see also *34 Fluid Mechanics and Heat Transfer.*

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## ASTRONAUTICS

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## MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.


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## PHYSICS

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**71 ACOUSTICS** 230
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For noise pollution see *45 Environment Pollution.*

**72 ATOMIC AND MOLECULAR PHYSICS** 231
Includes atomic structure, electron properties, and molecular spectra.

**73 NUCLEAR AND HIGH-ENERGY PHYSICS** 233
Includes elementary and nuclear particles; and reactor theory.
For space radiation see *93 Space Radiation.*

**74 OPTICS** 235
Includes light phenomena and optical devices.
For lasers see *36 Lasers and Masers.*

**75 PLASMA PHYSICS** 236
Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics.* For space plasmas see *90 Astrophysics.*

**76 SOLID-STATE PHYSICS** 243
Includes superconductivity.
For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**77 THERMODYNAMICS AND STATISTICAL PHYSICS** 247
Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

## SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

**80 SOCIAL SCIENCES (GENERAL)** N.A.
Includes educational matters.

**81 ADMINISTRATION AND MANAGEMENT** N.A.
Includes management planning and research.

**82 DOCUMENTATION AND INFORMATION SCIENCE** 247
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.
For computer documentation see *61 Computer Programming and Software.*

**83 ECONOMICS AND COST ANALYSIS** 249
Includes cost effectiveness studies.

**84 LAW, POLITICAL SCIENCE AND SPACE POLICY** 249
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**85 URBAN TECHNOLOGY AND TRANSPORTATION** 249
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

## SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
For related information see also *Geosciences.*

**88 SPACE SCIENCES (GENERAL)** N.A.

**89 ASTRONOMY** 250
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**90 ASTROPHYSICS** 251
Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
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**91 LUNAR AND PLANETARY EXPLORATION** 254
Includes planetology; and manned and unmanned flights.
For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**92 SOLAR PHYSICS** 254
Includes solar activity, solar flares, solar radiation and sunspots.
For related information see *93 Space Radiation.*

**93 SPACE RADIATION** N.A.
Includes cosmic radiation; and inner and outer earth's radiation belts.
For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

## GENERAL

Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

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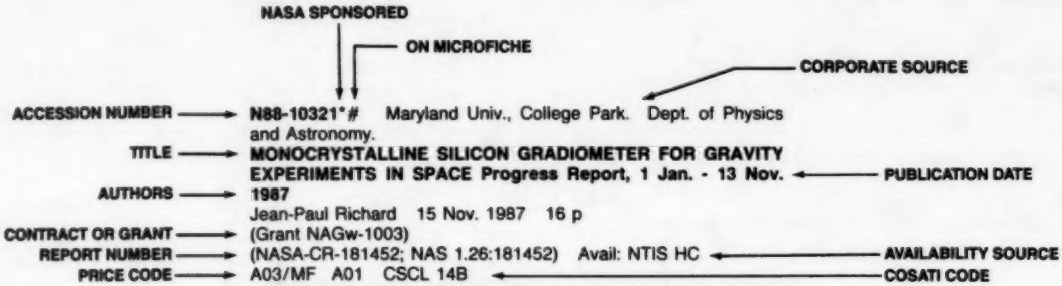


A very important research effort has been made in the last decade in the field of high precision measurement with laser instrumentation. The development of a space borne gradiometer operating at a high sensitivity level using laser measurement of the distance between proof mass over a short base line of order one meter is discussed. Two aspects of laser technology make it a promising tool for gradiometry measurements: quantum limited accuracy and absolute distance measurements. The quantum limit associated with laser instrumentation was formulated. The relevant quantum and classical sources of errors in laser measurements were reviewed and corresponding laser performance requirements for gradient measurements were evaluated. Some mechanical quality factor measurements were made on simple resonant monocrystalline silicon suspensions. It was discovered that the use of zero derivative restoring forces to position the gradiometer test masses will dramatically reduce the gradiometer temperature control requirements. A laser beam side injection scheme was discovered which permits rejection of common mode accelerations. These concepts are briefly discussed. Author

VOLUME 26 NUMBER 2 / JANUARY 23, 1988

# Scientific and Technical Aerospace Reports

*A Semimonthly Publication of the National Aeronautics and Space Administration*

## 01 AERONAUTICS (GENERAL)

**N88-10986#** Joint Publications Research Service, Arlington, Va.
**ENSURING THE SERVICE LIFE OF DESIGNS (EXPERIENCE IN AIRCRAFT CONSTRUCTION)**
A. F Selikhov and Zhukovskiy *In its* USSR Report: Engineering and Equipment 4 May 1987 p 1-11 Transl. into ENGLISH from Mashinovedeniye (Moscow, USSR), no. 5, Sep.-Oct. 1986 p 11-18 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

## 02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

**N88-10765*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**COMPARISON OF WIND TUNNEL AND FLIGHT TEST AFTERBODY AND NOZZLE PRESSURES FOR A TWIN-JET FIGHTER AIRCRAFT AT TRANSONIC SPEEDS**
Jack Nugent and Odis C. Pendergraft, Jr. Mar. 1987 125 p
(NASA-TP-2588; H-1214; NAS 1.60:2588) Avail: NTIS HC A06/MF A01 CSCL 01A

Afterbody and nozzle pressures measured on a 1/12-scale model and in flight on a twin-jet fighter aircraft were compared as Mach number varied from 0.6 to 1.2, Reynolds number from 17.5 million to 302.5 million, and angle of attack from 1 to 7 deg. At Mach 0.6 and 0.8, nozzle pressure coefficient distributions and nozzle axial force coefficients agreed and showed good recompression. At Mach 0.9 and 1.2, flow complexity caused a loss in recompression for both flight and wind tunnel nozzle data. The flight data exhibited less negative values of pressure coefficient and lower axial force coefficients than did the wind tunnel data. Reynolds number effects were noted only at these Mach numbers. Jet temperature and mass flux ratio did not affect the comparisons of nozzle axial flow coefficient. At subsonic speeds, the levels of pressure coefficient distributions on the upper fuselage and lower nacelle surfaces for flight were less negative than those for the model. The model boundary layer thickness at the aft rake station exceeded that for the forward rake station and increased with increasing angle of attack. The flight boundary layer thickness at the aft rake station was less than that for the forward rake station and decreased with increasing angle of attack. Author

**N88-10766** Michigan State Univ., East Lansing.
**LAMINAR FLOW OVER A SPINNING PROJECTILE AT AN ANGLE OF ATTACK Ph.D. Thesis**
Fouad Ahmed Youssef 1987 119 p
Avail: Univ. Microfilms Order No. DA8714377

The study of forces and moments on a spinning pointed body at an angle of attack is extremely important in ballistics. The governing Navier-Stokes equations are nonlinear and fully three-dimensional, making analysis impossible and direct numerical solutions impractical. The most promising theoretical techniques is the unsteady cross flow analogy. Considering the axial direction as timelike, the pressure and flow field can be obtained from the impulsive starting of a two-dimensional cylinder. Although the analogy is heuristic, the results do correlate well with experimental data on slender bodies for subsonic through supersonic free stream speeds. The impulsive starting of expanding, rotating cylinders is investigated. The results are used to calculate the force and moment coefficients for projectiles by means of the unsteady cross flow analogy. The unsteady Navier-Stokes equations are solved using matched asymptotic inner-outer perturbation method and comparing these results with the solution obtained using numerical methods. Excellent agreement between the two methods was established in the region where both solutions are valid. The results are consistent with existing experimental work. The numerical scheme showed stability and robustness in the integration of the full Navier-Stokes. Dissert. Abstr.

**N88-10767#** Texas Univ., Austin. Dept. of Aerospace Engineering and Engineering Mechanics.
**THE AEROTHERMODYNAMIC ENVIRONMENT FOR HOLES IN HYPERSONIC CONFIGURATIONS**
John J. Bertin, William J. Tedeschi, Albino C. Bustamante, and Eric W. Reece (Sandia National Labs., Albuquerque, N. Mex.) Aug. 1987 34 p Presented at the AIAA Aerodynamics Flight Mechanics Conference, Monterey, Calif., 17-19 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-014651; SAND-86-2875C-FP; CONF-870830-2-FP) Avail: NTIS HC A03/MF A01

A series of test programs have been conducted in Tunnel B of the Arnold Engineering Development Center (AEDC) in which wedges and spherically-blunted cones (with surface openings and base vents) were exposed to a Mach 8 stream. Measurements of the heat transfer and pressure from the recompression face of the external surface port were compared with the corresponding values computed using the rotational method-of-characteristics for a nonadiabatic, two-dimensional flow. The computed flow field provided reasonable estimates of the experimental measurements. Over the range of test conditions, the expansion-fan flow directly impinged on only a small fraction of the surface port recompression face and it immersed the entire recompression face. The recompression pressures and heat-transfer rates could be correlated as a function of the cavity pressure ratio. DOE

**N88-10768*#** Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
**VORTEX/BOUNDARY-LAYER INTERACTIONS: DATA REPORT, VOLUME 1 Final Report**
A. D. Cutler and P. Bradshaw Jun. 1987 82 p
(Grant NAGw-581)
(NASA-CR-181462; NAS 1.26:181462; IC-Aero-TN-87-102-Vol-1)
Avail: NTIS HC A05/MF A01 CSCL 01A

This report summarizes the work done under NASA Grant NAGw-581, Vortex/Boundary Layer Interactions. The experimental methods are discussed in detail and numerical results are presented, but are not fully interpreted. This report should be useful to anyone who wishes to make further use of the data (available on floppy disc or magnetic tape) for the development of turbulence models or the validation of predictive methods. Journal papers are in course of preparation. Author

**N88-10769*#** Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
**VORTEX/BOUNDARY-LAYER INTERACTIONS: DATA REPORT, VOLUME 2 Final Report**
A. D. Cutler and P. Bradshaw Jun. 1987 150 p
(Grant NAGw-581)
(NASA-CR-181463; NAS 1.26:181463; IC-Aero-TN-87-102-Vol-2) Avail: NTIS HC A07/MF A01 CSCL 01A

This report summarizes the work done under NASA grant NAGw-581, Vortex/Boundary-Layer Interactions, to date. The experimental methods are discussed in detail and the results presented as a large number of figures, but are not fully interpreted. This report should be useful to anyone who wishes to make further use of the data (available on floppy disc or magnetic tape) for the development of turbulence models or the validation of predictive methods. Journal papers are in preparation. Author

**N88-10770#** National Aerospace Lab., Tokyo (Japan).
**NUMERICAL COMPUTATION OF TRANSONIC POTENTIAL FLOW ABOUT 3-DIMENSIONAL INLETS**
Takashi Nakamura Mar. 1987 13 p In JAPANESE; ENGLISH summary
(NAL-TR-924; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

A highly efficient computer algorithm was developed for prediction of transonic nacelle/inlet flow fields. This algorithm can compute the three-dimensional transonic flow field about axisymmetric or asymmetric nacelle/inlet configurations with or without centerbody at zero or nonzero incidence. The flow field is determined by solving the full-potential equation in conservative form on a body-fitted curvilinear coordinate system. The coordinate system is generated by the conformal mapping method. The difference equations are solved using the AF2 approximate factorization scheme. Computed results are presented to illustrate application of the algorithms. Author

**N88-10771*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**EFFECT OF EMPENNAGE ARRANGEMENT ON SINGLE-ENGINE NOZZLE/AFTERBODY STATIC PRESSURES AT TRANSONIC SPEEDS**
William P. Henderson and James R. Burley, II Nov. 1987 230 p
(NASA-TP-2753; L-16223; NAS 1.60:2753) Avail: NTIS HC A11/MF A01 CSCL 01A

An investigation has been conducted in the Langley 16-Foot Transonic Tunnel to determine the effects on empennage arrangement on single-engine nozzle/afterbody static pressures. Tests were done at Mach numbers from 0.60 to 1.20, nozzle pressure ratios from 1.0 (jet off) to 8.0, and angles of attack from -3 to 9 deg (at jet off conditions), depending on Mach number. Three empennage arrangements (aft, staggered, and forward) were investigated. Extensive measurements were made of static pressure on the nozzle/afterbody in the vicinity of the tail surfaces. Author

**N88-10772*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**WALL INTERFERENCE TESTS OF A CAST 10-2/DOA 2 AIRFOIL IN AN ADAPTIVE-WALL TEST SECTION**
Raymond E. Mineck Dec. 1987 100 p
(NASA-TM-4015; L-16334; NAS 1.15:4015) Avail: NTIS HC A05/MF A01 CSCL 01A

A wind-tunnel investigation of a CAST 10-2/DOA 2 airfoil model has been conducted in the adaptive-wall test section of the Langley 0.3-Meter Transonic Cryogenic Tunnel (TCT) and in the National Aeronautical Establishment High Reynolds Number Aeronautical Establishment High Reynolds Number Two-Dimensional Test Facility. The primary goal of the tests was to assess two different wall-inteference correction techniques: adaptive test-section walls and classical analytical corrections. Tests were conducted over a Mach number range from 0.3 to 0.8 and over a chord Reynolds number range from 6 million to 70 million. The airfoil aerodynamic characteristics from the tests in the 0.3-m TCT have been corrected for wall interference by the movement of the adaptive walls. No additional corrections for any residual interference have been applied to the data, to allow comparison with the classically corrected data from the same model in the conventional National Aeronautical Establishment facility. The data are presented graphically in this report as integrated force-and-movement coefficients and chordwise pressure distributions. Author

**N88-10773*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**INTEGRATION EFFECTS OF D-SHAPED, UNDERWING AFT-MOUNTED, SEPARATE-FLOW, FLOW-THROUGH NACELLES ON A HIGH-WING TRANSPORT**
Milton Lamb, John R. Carlson, and Odis C. Pendergraft, Jr. Nov. 1987 24 p
(NASA-TM-4018; L-16342; NAS 1.15:4018) Avail: NTIS HC A03/MF A01 CSCL 01A

An experimental investigation was conducted in the Langley 16-Foot Transonic Tunnel at freestream Mach numbers from 0.70 to 0.82 and angles of attack from -3.0 to 4.0 deg to determine the integration effects of D-shaped, underwing, aft-mounted, separate-flow, flow-through nacelles on a high-wing transonic transport configuration. The results showed that the aft-mounted nacelle/pylon produced an increase in lift over that of the wing-body configuration by pressurizing much of the wing lower surface in front of the pylon. For the D-shaped nacelle, a substantial region of supersonic flow over the wing, aft of the lip of the nacelle, cancelled the reduction in drag caused by the increase in pressures ahead of the lip, to increase interference and form drag compared with a similar circular-shaped nacelle. The installed drag of the D=shaped nacelle was essentially the same as that of an aft-mounted circular nacelle from a previous investigation. Author

**N88-10774#** Dornier-Werke G.m.b.H., Friedrichshafen (West Germany). Hauptabteilung Aerodynamik.
**PARACHUTE CHARACTERISTICS OF TITAN DESCENT MODULES Final Report**
E. Achtermann, R. Kapp, and H. Lehra Paris, France ESA Feb. 1986 109 p
(Contracts ESTEC-6364/85; DS-86887-A-02633)
(BF-3/86-B; ESA-CR(P)-2438; ETN-87-90894) Avail: NTIS HC A06/MF A01

The deceleration and the descent of a planetary entry probe with a parachute system is investigated. The aerodynamic coefficients of the probe are estimated, including wake effects. Technical data concerning the parachute deceleration system of three planetary landers (Viking, Pioneer, and Galileo) are used as a guide for a basic layout of the Titan parachute system. Descent profiles with different deceleration systems are determined including density variations as well as zonal shear winds. Statistical weight data of conical ribbon parachutes, component weights of the Titan parachute system, and decelerator pack densities are presented. Probe spinning during descent is investigated for different spin vane dimensions and incidences. The descent simulation shows the damping characteristics of the probe due to a disturbance of the angle of attack at various points of the descent trajectory. Criteria for parachute material selection and parachute material characteristics are proposed. ESA

**N88-10775#** Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
**THE PHENOMENOLOGY OF KARMAN VORTEX STREETS VIA SOUND IN OSCILLATORY FLOW**
Elisabeth Detemple 1987 85 p In GERMAN; ENGLISH summary
(MPIS-Mitt-84-1987; ISSN-0374-1257; ETN-87-91044) Avail: NTIS HC A05/MF A01

Vortex wakes of circular cylinders at low Reynolds numbers were investigated. Sound waves are superimposed on the flow in mean flow direction. The Karman vortices are shed at the sound frequency or at subharmonics of the sound frequency. The Karman vortex street is treated as a nonlinear self-excited flow oscillator

with forced oscillations. Using a flow visualization technique wake structures is identified as a function of sound frequency and sound amplitude, but independent of Reynolds number. The superimposed sound influences the distribution of circulation and accordingly the shedding mechanism. Primary vortex and secondary vortex are shed simultaneously from one side of the cylinder. The alternate vortex shedding is arranged spatially and temporally. Structures along the vortices are revealed. ESA

**N88-10776*#** National Aeronautics and Space Administration, Washington, D.C.
**CALCULATION OF AERODYNAMIC HEAT TRANSFER FOR BLUNT-NOSED THIN WINGS AT DIFFERENT ANGLES OF ATTACK AT SUPERSONIC SPEEDS**
Shuxuan Xu Nov. 1987 17 p Transl. into ENGLISH from Acta Aerodynamica Sinica (People's Republic of China), v. 4, Dec. 1986 p 398-405 Original language document was announced in IAA as A87-28338 Transl. By Kanner (Leo) Associates, Redwood City, Calif. Prepared by China Univ. of Science and Technology, People's Republic of China
(Contract NASw-4005)
(NASA-TT-20127; NAS 1.77:20127) Avail: NTIS HC A03/MF A01 CSCL 01A

A method for calculating aerodynamic heat transfer on thin wings at angles of attack is provided, based on the assumption of small cross flow and the calculation of an infinite cylinder. It is valid in the range of supersonic and hypersonic speeds. The method does not require calculation of the details of the stream lines and can be used for various swept wings at moderate angle of attack or yaw angle. A comparison between theoretical and experimental results is given. Author

**N88-10777*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**ANALYTICAL MODELING OF HELICOPTER STATIC AND DYNAMIC INDUCED VELOCITY IN GRASP**
Donald L. Kunz and Dewey H. Hodges (Georgia Inst. of Tech., Atlanta.) Nov. 1987 10 p
(NASA-TM-100026; A-87341; NAS 1.15:100026; USAAVSCOM-TR-87-A-11) Avail: NTIS HC A02/MF A01 CSCL 01A

The methodology used by the General Rotorcraft Aeromechanical Stability Program (GRASP) to model the characteristics of the flow through a helicopter rotor in hovering or axial flight is described. Since the induced flow plays a significant role in determining the aeroelastic properties of rotorcraft, the computation of the induced flow is an important aspect of the program. Because of the combined finite-element/multibody methodology used as the basis for GRASP, the implementation of induced velocity calculations presented an unusual challenge to the developers. To preserve the modelling flexibility and generality of the code, it was necessary to depart from the traditional methods of computing the induced velocity. This is accomplished by calculating the actuator disc contributions to the rotor loads in a separate element called the air mass element, and then performing the calculations of the aerodynamic forces on individual blade elements within the aeroelastic beam element. Author

**N88-10778*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**NAVIER-STOKES CASCADE ANALYSIS WITH A STIFF KAPPA-EPSILON TURBULENCE SOLVER**
Jong-Shang Liu, Peter M. Sockol, and Joseph M. Prahl (Case Western Reserve Univ., Cleveland, Ohio.) [1987] 15 p Prepared for presentation at the 26th Aerospace Sciences Meeting, Reno, Nev., 11-14, 1988; sponsored by AIAA
(NASA-TM-100218; ICOMP-87-6; E-3829; NAS 1.15:100218; AIAA-88-0594) Avail: NTIS HC A03/MF A01 CSCL 01A

The two dimensional, compressible, thin layer Navier-Stokes equations with the Baldwin-Lomax turbulence model and the kinetic energy-energy dissipation (k-epsilon) model are solved numerically to simulate the flow through a cascade. The governing equations are solved for the entire flow domain, without the boundary layer assumptions. The stiffness of the k-epsilon equations is discussed. A semi-implicit, Runge-Kutta, time-marching scheme is developed to solve the k-epsilon equations. The impact of the k-epsilon solver on the explicit Runge-Kutta Navier-Stokes solver is discussed. Numerical solutions are presented for two dimensional turbulent flow over a flat plate and a double circular arc cascade and compared with experimental data. Author

**N88-10779*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**A NATURAL LOW FREQUENCY OSCILLATION IN THE WAKE OF AN AIRFOIL NEAR STALLING CONDITIONS**
K. B. M. Q. Zaman and D. J. McKinzie [1987] 17 p Prepared for presentation at the 26th Aerospace Sciences Meeting, Reno, Nev., 11-14 Jan. 1988; sponsored by AIAA
(NASA-TM-100213; E-3822; NAS 1.15:100213; AIAA-88-0131)
Avail: NTIS HC A03/MF A01 CSCL 01A

An unusually low frequency oscillation in the flow over an airfoil was explored experimentally. Wind tunnel measurements were carried out with a two dimensional airfoil model at a chord Reynolds number of 100,000. During deep stall the usual bluff-body shedding occurred at a Strouhal number. But at the onset of stall a low frequency periodic oscillation occurred, the corresponding Strouhal number being an order of magnitude lower. The phenomenon occurred in relatively unclean flow when the freestream turbulence was raised to 0.4 percent, but did not in the cleaner flow with turbulence intensity of 0.1 percent. It could also be produced by certain high frequency acoustic excitation. Details of the flow field are compared between a case of low frequency oscillation at alpha = 15 deg and a case of bluff-body shedding at alpha = 22.5 deg. The origin of the low frequency oscillation traces to the upper surface of the airfoil and is seemingly associated with the periodic formation and breakdown of a large separation bubble. The intense flow fluctuations impart significant unsteady forces to the airfoil but diminish rapidly within a distance of one chord from the trailing edge. Author

# 03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

**N88-10780#** National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.
**AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORTS: UNALASKA, ALASKA, SEPTEMBER 25, 1985; JENKINSBURG, GEORGIA, SEPTEMBER 29, 1985; BOSTON, MASSACHUSETTS, DECEMBER 15, 1985; DEKALB, TEXAS, DECEMBER 31, 1985; AND ERIE, PENNSYLVANIA, FEBRUARY 21, 1986**
30 Jun. 1987 46 p
(PB87-910408; NTSB/AAR-87/02/Sum) Avail: NTIS HC A03/MF A01; also available on subscription, North American Continent HC $60.00/year, all others write for quote CSCL 01C

The publication is a compilation of reports of aviation accidents investigated by the National Transportation Safety Board. The accident locations and dates are as follows: Unalaska, Alaska, September 25, 1985; Jenkinsburg, Georgia, September 29, 1985; Boston, Massachusetts, December 15, 1985; Dekalb, Texas, December 31, 1985; and Erie, Pennsylvania, February 21, 1986. GRA

**N88-10781#** National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
**AIRCRAFT ACCIDENT REPORTS, BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION. ISSUE NUMBER 1: 1986 ACCIDENTS**
28 May 1987 410 p
(PB87-916903; NTSB/AAB-87/03) Avail: NTIS HC A18/MF

A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01C

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1986. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

**N88-10782#** Transportation Research Board, Washington, D.C.
**ISSUES IN AIR TRANSPORT AND AIRPORT MANAGEMENT**
J. P. Schwieterman, F. A. Spencer, M. Ghafouri, T. N. Lam, and J. R. G. Brander 1986 58 p
(PB87-204509; TRB/TRR-1094; ISBN-309-04114-7; LC-87-7628)
Avail: NTIS HC A04/MF A01 CSCL 01C

The six papers in this report deal with the following: alternatives to the hub; a survey of nonstop air service opportunities; accessibility in the deregulated domestic airline network; air transport deregulation and airport congestion; the search for efficient solutions; methodology for planning and operations management of airport terminal facilities; a prescription for efficient management of the Canadian Government's civilian aircraft fleet; and analyzing the financial impact on airports of remote airport ground transportation. GRA

**N88-10783#** General Accounting Office, Washington, D. C. Resources, Community and Economic Development Div.
**AVIATION SECURITY: FAA (FEDERAL AVIATION ADMINISTRATION) NEEDS PREBOARD PASSENGER SCREENING PERFORMANCE STANDARDS**
Jul. 1987 16 p
(PB87-216800; GAO/RCED-87-182; B-226652) Avail: NTIS HC A03/MF A01 CSCL 01C

The report provides the results of work to date on the Federal Aviation Administration (FAA) testing of pre-boarding passenger screening. It found shortfalls in the screening program and, on the basis of FAA test results, wide variations in the frequency with which weapons were detected. Conclusions are based on work at 6 major airports, an analysis of some 2400 recent FAA screening tests, discussions with FAA program officials, and a review of FAA documentation. GRA

# 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

**N88-10784** Alabama Univ., Huntsville.
**GLOBAL POSITIONING SATELLITE-BASED AUTOMATIC LANDING SYSTEM AND WIND ESTIMATED FEEDBACK FOR THE AH-64 HELICOPTER Ph.D. Thesis**
Abdollah Homaifar 1986 288 p
Avail: Univ. Microfilms Order No. DA8713429

A real time simulation of a helicopter is used to investigate the Global Positioning Satellite guidance and control during a fully automatic spiral descent and landing flare maneuver in the presence of crosswind and turbulence. The spiral descent offers a landing pattern, restricted in area, which is useful near congested airports, for both civil and military operations. It was shown that combined optimal estimation and control techniques are feasible for reduction of spiral descent guidance errors. The optimal estimation is accomplished using an extended Kalman filter, resulting in an estimated state of an aircraft and crosswind. This estimated state constitutes an input to an optimal linear regulator. Improvements in accuracy are made by adding an altimeter and body mounted accelerometers. Modifications of the steady-state, reduced-order Kalman filter are described which provide a satisfactory estimator in such cases. The results of applying these techniques to the design of an estimator for aircraft position and crosswind are presented. A design of an optimal controller for spiral descent and landing flare with augmented crosswind is also included. The linear optimal regulator theory is utilized to derive state feedback gain for guidance and control. The estimator and controller performances are verified using a Monte Carlo simulation. Dissert. Abstr.

**N88-10810#** Carleton Univ., Ottawa (Ontario). Dept. of System and Computer Engineering.
**AN EXPERT SYSTEM FOR AIRCRAFT CONFLICT RESOLUTION IN DENSE AIRSPACES**
B. A. Bowen *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 13 p Sponsored by Transport Canada (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

**N88-10815#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugfuehrung.
**A RULE-BASED SYSTEM FOR ARRIVAL SEQUENCING AND SCHEDULING IN AIR TRAFFIC CONTROL**
U. Voelckers *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-08)
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# 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics.* For land transportation vehicles see *85 Urban Technology and Transportation.*

**N88-10785#** Sandia National Labs., Albuquerque, N. Mex. Aeroballistics Div.
**STORE SEPARATION OF NUCLEAR WEAPONS**
Harold R. Spahr 1987 9 p Presented at the AEROTECH '87: Society of Automotive Engineers Conference and Exposition, Long Beach, Calif., 5 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-010778; SAND-87-1370C; CONF-871085-1) Avail: NTIS HC A02

Aircraft-delivered nuclear weapons continue to play an important part as the only recallable component in the United States nuclear deterrent triad. Nuclear weapons have unique characteristics which must be considered in evaluating their store separation characteristics. These considerations start in the preliminary design phase. Then, theoretical analyses, wind tunnel store separation testing, and full-scale flight drop tests are used together in a cost effective manner to evaluate store separation characteristics. Several examples of the applications of these methods are presented. DOE

**N88-10786#** Sandia National Labs., Albuquerque, N. Mex.
**AERODYNAMIC DESIGN AND PERFORMANCE OF A BENT-AXIS GEOMETRY VEHICLE**
W. H. Rutledge, G. F. Polansky, and E. L. Clark 1987 14 p Presented at the AIAA Aerodynamics Flight Mechanics Conference, Monterey, Calif., 17 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-013726; SAND-87-0118C; CONF-870830-7; AIAA-87-2491-CP) Avail: NTIS HC A03

Variable bent-axis maneuvering vehicles provide a unique type of control for a variety of supersonic and hypersonic missions. Unfortunately, the large hinge moments often associated with these

vehicles have prevented their application. This study examines the application of both experimental data and Computational Aerodynamics (CA) techniques in the design of such vehicles. A procedure is presented for the efficient design of a bent-axis geometry given a set of system constraints. In particular, the selection of vehicle parameters to produce minimum hinge moments for trimmed flight is examined in detail. Finally, the overall performance of the bent-axis geometry is reviewed in terms of static stability, lift/drag ratio and control effectiveness. DOE

**N88-10787#** Loughborough Univ. of Technology (England). Dept. of Electrical and Electronic Engineering.
**DECOUPLING AND STABILIZATION OF SPEED AND HEIGHT IN F4 PHANTOM AIRCRAFT USING OUTPUT FEEDBACK M.S. Thesis**
J. M. Hammer 1987 176 p
(ETN-87-90926) Avail: NTIS HC A09/MF A01

The equations of motion of an F4 aircraft are numerically evaluated for straight and level flight at Mach 1.1 at sea level. The inputs of the system are speed demand and height demand; the outputs are speed and height, to be stabilized and decoupled using output feedback and cascade compensation. The algebraic approach, the root locus approach, and the frequency response approach are compared. The first two have considerable drawbacks, the major one being the necessity to specify exactly the pole positions in the stabilized aircraft when a large range of pole positions is acceptable. The frequency response approach, however, provides a logical and methodical means of arriving at solutions for the compensation matrix elements, with the stability of the aircraft response being clearly displayed on a Nichols Chart. ESA

**N88-10788*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**FLIGHT RESEARH AT NASA AMES RESEARCH CENTER: A TEST PILOT'S PERSPECTIVE**
G. Warren Hall Sep. 1987 13 p
(NASA-TM-100025; A-87323; NAS 1.15:100025) Avail: NTIS HC A03/MF A01 CSCL 01C

In 1976 NASA elected to assign responsibility for each of the various flight regimes to individual research centers. The NASA Ames Research Center at Moffett Field, California was designated lead center for vertical and short takeoff and landing, V/STOL research. The three most recent flight research airplanes being flown at the center are discussed from the test pilot's perspective: the Quiet Short Haul Research Aircraft; the XV-15 Tilt Rotor Research Aircraft; and the Rotor Systems Research Aircraft. Author

**N88-10812#** Royal Aircraft Establishment, Farnborough (England).
**TOWARDS THE UNMANNED COCKPIT**
Brian Ellis *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-06)
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# 06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

# 07 AIRCRAFT PROPULSION ANL POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

**N88-10789#** Rolls-Royce Ltd., Derby (England).
**THE WIDE CHORD FAN BLADE: A ROLLS ROYCE FIRST**
D. J. Nicholas 1 Jun. 1987 31 p Presented at the 8th ISABE Conference, Cincinnati, Ohio, 15-19 Jun. 1987
(PNR90416; ETN-87-91005) Copyright Avail: NTIS HC A03/MF A01

The performance benefits of the wide chord fan compared to the conventional, snubbered, high aspect ratio design are described. The main mechanical design aspects of the fabricated blade are outlined. Criteria such as the choice of blade numbers, FOD resistance, cyclic fatigue, and vibration characteristics are examined together with the computer modeling and method of stressing which ensures the correct aerodynamic shape under centrifugal and pressure load conditions. The physical construction of the blade and the method of manufacture are summarized. The RB 211-535 E4 service record is reviewed. ESA

**N88-10790*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**STABILITY RELATIONSHIP FOR WATER DROPLET CRYSTALLIZATION WITH THE NASA LEWIS ICING SPRAY**
C. John Marek and C. Scott Bartlett (Sverdrup Technology, Inc., Arnold Air Force Station, Tenn.) [1987] 20 p Prepared for presentation at the 26th Aerospace Sciences Meeting, Reno, Nev., 11-14 Jan. 1988; sponsored by AIAA
(NASA-TM-100220; E-3832; NAS 1.15:100220; AIAA-88-0289)
Avail: NTIS HC A03/MF A01 CSCL 14B

In order to produce small droplets for icing cloud simulation, high pressure air atomizing nozzles are used. For certain icing testing applications, median drop sizes as small as 5 mm are needed, which require air atomizing pressures greater than 3000 kPa. Isentropic expansion of the ambient temperature atomizing air to atmospheric pressure can result in air stream temperatures of -160 C which results in ice crystals forming in the cloud. To avoid such low temperatures, it is necessary to heat the air and water to high initial temperatures. An icing spray research program was conducted to map the temperatures below which ice crystals form. A soot slide technique was used to determine the presence of crystals in the spray. Author

**N88-10791*#** General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
**BLADE LOSS TRANSIENT DYNAMICS ANALYSIS, VOLUME 1. TASK 2: TETRA 2 THEORETICAL DEVELOPMENT Final Report**
Vincente C. Gallardo and Gerald Black Nov. 1986 92 p
(Contract NAS3-24381)
(NASA-CR-179632; NAS 1.26:179632) Avail: NTIS HC A05/MF A01 CSCL 21E

The theoretical development of the forced steady state analysis of the structural dynamic response of a turbine engine having nonlinear connecting elements is discussed. Based on modal synthesis, and the principle of harmonic balance, the governing relations are the compatibility of displacements at the nonlinear connecting elements. There are four displacement compatibility equations at each nonlinear connection, which are solved by iteration for the principle harmonic of the excitation frequency. The resulting computer program, TETRA 2, combines the original TETRA transient analysis (with flexible bladed disk) with the steady state capability. A more versatile nonlinear rub or bearing element which contains a hardening (or softening) spring, with or without deadband, is also incorporated. Author

**N88-10792*#** General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
**BLADE LOSS TRANSIENT DYNAMICS ANALYSIS, VOLUME 2. TASK 2: TETRA 2 USER'S MANUAL Final Report**
Gerald Black and Vincente C. Gallardo Nov. 1986 204 p
(Contract NAS3-24381)
(NASA-CR-179633; NAS 1.26:179633) Avail: NTIS HC A10/MF A01 CSCL 21E

This is the user's manual for the TETRA 2 Computer Code, a program developed in the NASA-Lewis Blade Loss Program. TETRA 2 calculates a turbine engine's dynamic structural response from applied stimuli. The calculation options are: (1) transient response; and (2) steady state forced response. Based on the method of modal syntheses, the program allows the use of linear, as well as nonlinear connecting elements. Both transient and steady state options can include: flexible Bladed Disk Module, and Nonlinear Connecting Elements (including deadband, hardening/softening spring). The transient option has the additional capability to calculate response with a squeeze film bearing module. TETRA 2 output is summarized in a plotfile which permits post processing such as FFT or graphical animation with the proper software and computer equipment. Author

**N88-10992#** Joint Publications Research Service, Arlington, Va.
**TURBINES WITH COUNTERROTATING RUNNERS FOR AIRCRAFT POWER PLANTS Abstract Only**
B. A. Ponomarev and Yu. V. Stosenko *In its* USSR Report: Engineering and Equipment 4 May 1987 p 93 Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy: Aviationnaya Tekhnika (Kazan, USSR), no. 2, Apr. - Jun. 1986 p 50-53 Original language document was announced in IAA as A87-15211 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

**N88-10993#** Joint Publications Research Service, Arlington, Va.
**DIAGNOSIS OF FLOW CHANNEL IN AIRCRAFT GAS-TURBINE ENGINES ON BASIS OF VIBRATION SPECTRUM CHARACTERISTICS Abstract Only**
A. G. Mironov and S. M. Doroshko *In its* USSR Report: Engineering and Equipment 4 May 1987 p 93 Transl. into ENGLISH from Izvestiya Vysshikh Uchebsnykh Zavedeniy: Aviatsionnaya Tekhnika (Kazan, USSR), no. 2, Apr. - Jun. 1986 p 45-49 Original language document was announced in IAA as A87-15210 (For primary document see N88-10985 02-31)
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**N88-11152*#** Garrett Turbine Engine Co., Phoenix, Ariz.
**COMBUSTOR-DIFFUSER INTERACTION PROGRAM**
R. Srinivasan and C. White *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 121-125 (For primary document see N88-11140 02-39)
(Contract F33615-84-C-2427)
Avail: NTIS HC A19/MF A01 CSCL 21E

# 08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

**N88-10793#** National Aerospace Lab., Tokyo (Japan).
**MEASUREMENTS IN THE FUNCTIONAL MOCK UP TEST OF THE NAL QSTOL AIRCRAFT CONTROL SYSTEM**
Akira Tada, Toshio Ogawa, Hiroyuki Yamato, Tadao Uchida, and Noriaki Okada Apr. 1987 30 p In JAPANESE; ENGLISH summary
(NAL-TR-928; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

In the functional mock up test of the NAL QSTOL research aircraft control system, measurements were planned and conducted with the intention of obtaining both real time results to support the development immediately, and reserved data suitable for academically rigorous and detailed analyses from various points of view. The physical quantities of 208 system variables were converted to analog voltage signals, and supplied from junction boxes to devices for recording and analysis. The system characteristics of primary interest in each test were investigated using chart recorders, a two-channel X-Y recorder, an FFT analyzer, and a monitoring unit of the on-board computers. A pre-processor unit of a minicomputer system converted 64 channels of the analog data to disk image digital data with a sampling rate of 100 Hx for each channel. Up to two hours of test data were temporarily stored in the desk file, and then, as a part of near time processings, were transferred to magnetic tapes for preservation. A digital filtering and sampling technique, designated the Filtering Sample, was applied to the conversion of the pre-processor unit. The Filtering Sample showed a good anti-aliasing effect within a reasonable increment of the processing work load. Author

**N88-10794#** Aeronautical Research Labs., Melbourne (Australia).
**A SURVEY OF AIRCRAFT INTEGRATED CONTROL TECHNOLOGY**
R. D. Hill Sep. 1987 28 p
(AR-004-561; ARL-SYS-TM-95) Avail: NTIS HC A03/MF A01

Current design techniques applied to aircraft flight control systems have been surveyed and the increasing use of modern control theory in the control system design of experimental technology demonstrator aircraft is described. The modern control system design methodology is seen to be particularly suitable for application to the design of controllers for complex, multivariable aircraft systems which are composed of dynamically interacting subsystems. These will typically include the flight control, propulsion, and weapon systems. Some suggestions regarding the most appropriate form of future ARL involvement in this large and expanding area are made. Author

**N88-10795#** Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.
**A PRELIMINARY INVESTIGATION INTO THE FEASIBILITY OF IMPLEMENTING A DIRECT SIDEFORCE CONTROL SYSTEM ON THE ASTRA HAWK BY MEANS OF AN ACTIVE CONTROL SURFACE M.S. Thesis**
V. A. English Sep. 1986 196 p
(ETN-87-90924) Avail: NTIS HC A09/MF A01

A computer program to test the effect of an auxiliary surface by simulating the direct sideforce modes of motion, in order to estimate the maximum mode performance benefits, was developed. The program is written as a design tool, which incorporates data for the flight envelope from Mach 0.3 to 0.8 and from sea level to 36,000 ft, for the basic aircraft, with provision to add in derivatives due to the auxiliary surface. The program can be used to re-evaluate the behavior of the aircraft with auxiliary surface as the aerodynamics, geometry of the surface, position of the surface on the airframe, and hence derivatives of the surface are revised. ESA

**N88-10796#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.
**FAULT TOLERANT CONSIDERATIONS AND METHODS FOR GUIDANCE AND CONTROL SYSTEMS**
Marc J. Pelegrin (Office National d'Etudes et de Recherches Aerospatiales, Toulouse, France ) Jul. 1987 136 p
(AGARD-AG-289; ISBN-92-835-1554-4) Copyright Avail: NTIS HC A07/MF A01

This AGARDograph, prepared and edited at the request of the Guidance and Control Panel of AGARD, presents a description of recent trends and developments in analysis and design methods for fault tolerant guidance and control systems architectures. The problems and issues associated with these architectures, including both hardware and software aspects, are addressed exploring the many developments under way in NATO in the following areas: advances in fault tolerant architectures; advances in analytical fault

detection methods; design considerations and methods; and analysis and testing methods. For individual titles, see N88-10797 through N88-10805.

**N88-10797#** Centre National de la Recherche Scientifique, Toulouse (France).
**COMPUTING SYSTEMS DEPENDABILITY AND FAULT TOLERANCE: BASIC CONCEPTS AND TERMINOLOGY c60**
J. C. Laprie *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 15 p (For primary document see N88-10796 02-08)
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Provided is a conceptual framework for expressing the constituents of dependable computing, i.e., the impairments to dependability: faults, errors and failures; the means for dependability: fault avoidance, fault tolerance, fault removal, and fault forecasting; the measures of dependability: reliability and availability. Emphasis is placed on the dependability impairments and on fault tolerance. Informal but precise definitions are given. Author

**N88-10798*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**THE APPLICATION OF EMULATION TECHNIQUES IN THE ANALYSIS OF HIGHLY RELIABLE, GUIDANCE AND CONTROL COMPUTER SYSTEMS**
Gerard E. Migneault *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 12 p (For primary document see N88-10796 02-08)
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Emulation techniques can be a solution to a difficulty that arise in the analysis of the reliability of guidance and control computer systems for future commercial aircraft. Described here is the difficulty, the lack of credibility of reliability estimates obtained by analytical modeling techniques. The difficulty is an unavoidable consequence of the following: (1) a reliability requirement so demanding as to make system evaluation by use testing infeasible; (2) a complex system design technique, fault tolerance; (3) system reliability dominated by errors due to flaws in the system definition; and (4) elaborate analytical modeling techniques whose precision outputs are quite sensitive to errors of approximation in their input data. Use of emulation techniques for pseudo-testing systems to evaluate bounds on the parameter values needed for the analytical tachniques is then discussed. Finally several examples of the application of emulation techniques are described. Author

**N88-10799#** Marconi Avionics Ltd., Rochester (England). Combat Aircraft Controls Div.
**SOME APPROACHES TO THE DESIGN OF HIGH INTEGRITY SOFTWARE**
J. T. Shepherd, D. J. Martin, and R. B. Smith *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 14 p Sponsored by Ministry of Defence, United Kingdom (For primary document see N88-10796 02-08)
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As the complexity of aircraft systems has increased and the performance requirements for such aircraft have become more demanding the number of safety critical systems carried has increased. This allied to the preponderance of digital systems on board the aircraft has meant that the software requirements of safety critical systems have become one of the key items in the development of new aircraft. In the early days of high integrity systems analog techniques were used and a variety of redundancy techniques developed to cope with the need to obtain the required level of integrity from system elements whose inherent reliability was low. With the advent of digital systems it is necessary to consider how much integrity can be achieved with system software so that the total integrity of a safety critical system can be maintained. This can be achieved by fault avoidance or fault tolerance. To date the former has been the main method used to achieve high integrity software. However, fault avoidance to be effective must assume an error free system, which is near impossible to achieve. Fault avoidance is combined with fault tolerance, which adjusts the system to its inherent errors, and is added to assure greater reliability. F.M.R.

**N88-10800#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Wesseling (West Germany). Inst. for Flight System Dynamics.
**ROBUST CONTROL SYSTEM DESIGN**
J. Ackermann *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 14 p Previously announced as N81-11275 (For primary document see N88-10796 02-08)
Copyright Avail: NTIS HC A07/MF A01

The short period longitudinal mode of an F 4-E with horizontal canards is unstable in subsonic flight and insufficiently damped at supersonic speed. The control system has to provide acceptable pole locations according to military specifications for flying qualities. A fixed gain controller using three paralleled gyros is designed, such that the pole region requirements in four typical flight conditions are robust with respect to a gain reduction to one third. Thus nothing bad happpens immediately when one or two gyros fail. Failure detection and redundancy management may be performed at a higher hierarchical level, and not necessarily extremely fast. The use of accelerometers or air data sensors for angle of attack or dynamic pressure is totally avoided in this concept and no gain scheduling is necessary. The design for robustness with respect to different flight conditions and sensor failures is performed by a novel parameter space design tool. Author

**N88-10801*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**RELIABILITY MODELING OF FAULT-TOLERANT COMPUTER BASED SYSTEMS**
Salvatore J. Bavuso *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 16 p (For primary document see N88-10796 02-08)
Copyright Avail: NTIS HC A07/MF A01 CSCL 01C

Digital fault-tolerant computer-based systems have become commonplace in military and commercial avionics. These systems hold the promise of increased availability, reliability, and maintainability over conventional analog-based systems through the application of replicated digital computers arranged in fault-tolerant configurations. Three tightly coupled factors of paramount importance, ultimately determining the viability of these systems, are reliability, safety, and profitability. Reliability, the major driver affects virtually every aspect of design, packaging, and field operations, and eventually produces profit for commercial applications or increased national security. However, the utilization of digital computer systems makes the task of producing credible reliability assessment a formidable one for the reliability engineer. The root of the problem lies in the digital computer's unique adaptability to changing requirements, computational power, and ability to test itself efficiently. Addressed here are the nuances of modeling the reliability of systems with large state sizes, in the Markov sense, which result from systems based on replicated redundant hardware and to discuss the modeling of factors which can reduce reliability without concomitant depletion of hardware. Advanced fault-handling models are described and methods of acquiring and measuring parameters for these models are delineated. Author

**N88-10802#** Centre d'Etudes et de Recherches, Toulouse (France).
**ISAURE: INTEGRATION OF SECURITY AND FAULT TOLERANCE IN THE REALITE 2000 SYSTEM**
J. Cazin and P. Michel *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 12 p (For primary document see N88-10796 02-08)
Copyright Avail: NTIS HC A07/MF A01

In the framework of the French SURF project sponsored by the Agence de l'Informatique (ADI), the ONERA/CERT research center and the Intertechnique Company have developed a fault-tolerant operating system called ISAURE. This system includes data protection features and error recovery mechanisms. It offers

the same services as the REALITE 2000 system already available on the market. It used first the Multi 6-Intertechnique microprocessor, and later specific hardware implementing protection domains via a capability based addressing mechanism. The collaboration between the two systems is the result of converging and complementary aims: the Intertechnique Company is trying to set up a future range of systems and machines oriented towards management applications and offering a high level of functional security; and the CERT/ONERA research center wishes to apply methodological research results and thus continue its research work in the context of practical applications. This collaboration is one of the more original features of the project and it allows introduction of advanced concepts into the industrial sector. Author

**N88-10803#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugfuehrung.

**OPTIMAL DETECTION OF SENSOR FAILURES IN FLIGHT CONTROL SYSTEMS USING DETERMINISTIC OBSERVERS**

Norbert Stuckenberg *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 21 p (For primary document see N88-10796 02-08)

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A failure detection scheme for sensors of a flight control system is presented. Based on analytic redundancy a duplex sensor configuration provides the fail-operational capability of a conventional triplex sensor system. This is achieved by using deterministic observers. It is shown how the performance of the failure detection scheme can be determined. With respect to this performance criterion the optimal observer is derived. Thus, the performance eventually achievable by an optimal failure detection scheme is also described. The operational feasibility of the proposed concept is demonstrated by flight test results. Author

**N88-10804#** Verilog S.A., Toulouse (France).

**ASSESSMENT OF SOFTWARE QUALITY FOR THE AIRBUS A310 AUTOMATIC PILOT**

R. Troy and C. Baluteau (Societe Francaise d'Equipements pour la Navigation Aerienne, Velizy-Villacoublay, France ) *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control System Jul. 1987 13 p (For primary document see N88-10796 02-08)

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As for the whole of the Automatic Flight Control System, the automatic pilot for the AIRBUS is a computer system with high criticality. In order to assess the quality of the software, a number of observations and measurements have been made during the development cycle. A general method of evaluation, the data collected, and some evaluation results are presented. The aims of this analysis are to assess the impact of development constraints on the quality of the product and to evaluate its operational reliability. The results show conditions in which software may be adversely affected by modifications. In particular, they make it possible to appreciate the quality of design, the effectiveness of the verification and validation processes, and the flexibility of the software. The last part gives a tentative example of operational reliability evaluation, taking into consideration the complexity of the functions and the mission profile. Author

**N88-10805*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**FLIGHT TEST OF A RESIDENT BACKUP SOFTWARE SYSTEM**

Dwain A. Deets, Wilton P. Lock, and Vincent A. Megna (Draper, Charles Stark Lab., Inc., Cambridge, Mass ) *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 9 p Previously announced as N86-19325 (For primary document see N88-10796 02-08)

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A new fault-tolerant system software concept employing the primary digital computers as host for the backup software portion has been implemented and flight tested in the F-8 digital fly-by-wire airplane. The system was implemented in such a way that essentially no transients occurred in transferring from primary to backup software. This was accomplished without a significant increase in the complexity of the backup software. The primary digital system was frame synchronized, which provided several advantages in implementing the resident backup software system. Since the time of the flight tests, two other flight vehicle programs have made a commitment to incorporate resident backup software similar in nature to the system described here. Author

**N88-10806#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.

**KNOWLEDGE BASED CONCEPTS AND ARTIFICIAL INTELLIGENCE: APPLICATIONS TO GUIDANCE AND CONTROL**

Aug. 1987 145 p Lectures held in Ottawa, Ontario, 10-11 Sep., in Monterey, Calif., 14-15 Sep., in Delft, Netherlands, 12-13 Oct., and in Lisbon, Portugal, 15-16 Oct. 1987

(AGARD-LS-155; ISBN-92-835-1588-7) Copyright Avail: NTIS HC A07/MF A01

The intent of this lecture series was to clearly describe what artificial intelligence techniques mean with respect to guidance and control applications, to offer some concrete examples of applications to the maintenance area, some more speculative examples of applications to actual guidance and control tasks, and a projection of possible directions for the future. For individual titles, see N88-10807 through N88-10817.

**N88-10807#** General Electric Co., Binghamton, N.Y.

**OVERVIEW OF AGARD LECTURE SERIES NO. 155: KNOWLEDGE-BASED CONCEPTS AND ARTIFICIAL INTELLIGENCE APPLICATIONS TO GUIDANCE AND CONTROL**

Rihcard Paul Quinlivan *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 5 p (For primary document see N88-10806 02-08)

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Several lectures dealing with artificial intelligence (AI) applications to guidance and control are reviewed. The use of various forms of AI techniques to help solve problems related to guidance and control is a subject of current interest. Most, if not all, of the practical applications utilize knowledge-based techniques to create so-called 'expert systems'. These systems seem to offer solutions to guidance and control problems that have a large judgment content. Examples include maintenance systems and real-time, decision aiding systems. Author

**N88-10808#** Analytic Sciences Corp., Reading, Mass.

**AI EXPERT SYSTEM TECHNOLOGY ISSUES FOR GUIDANCE AND CONTROL APPLICATIONS**

Harold L. Jones *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 7 p (For primary document see N88-10806 02-08)

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A perspective is provided on a set of technical issues, which, if unresolved, could limit the capability and acceptability of expert systems decision making for avionics applications. Examples from ongoing expert system development programs are used to illustrate likely architectures and applications of future intelligent avionics systems. Author

**N88-10809#** Electronique Serge Dassault, St. Cloud (France).

**DEDALE: AN EXPERT SYSTEM FOR ANALOG CIRCUIT MAINTENANCE** **c33**

Michel Muenier and Philippe Deves *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-08)

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DEDALE is an expert system designed to cover the diagnostic phase of an analog circuit. DEDALE allows the fast and intelligent identification of circuit faults. Its ability is not limited to a few

circuits; it is able to troubleshot fairly quickly any new circuit with minimum initial knowledge. Author

**N88-10810#** Carleton Univ., Ottawa (Ontario). Dept. of System and Computer Engineering.
**AN EXPERT SYSTEM FOR AIRCRAFT CONFLICT RESOLUTION IN DENSE AIRSPACES** **c04**
B. A. Bowen *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 13 p Sponsored by Transport Canada (For primary document see N88-10806 02-08)
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A hybrid, knowledge-based system is described which provides advice to air traffic controllers on the optimal tactics for resolving predicted aircraft conflicts. The overall functional architecture is described which has both computational algorithms and rule bases containing the knowledge and experience of controllers in the air traffic environment. The system is designed to replicate the way a controller might react to a predicted conflict. It responds to conflict predictions with resolution advice, which depends on both formal rules and on heuristics obtained from controllers. Author

**N88-10811#** Lear Siegler, Inc., Grand Rapids, Mich. Instrument and Avionic Systems Div.
**APPLICATION OF KNOWLEDGE-BASED TECHNIQUES TO AIRCRAFT TRAJECTORY GENERATION AND CONTROL**
Michael W. Bird *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-08)
(Contract F33615-84-C-3626)
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A concept that embeds the knowledge-based techniques in a trajectory generation and control system is defined. The control system is called the Unified Trajectory control System (UTCS). The objective of the system is to aid the pilot when operating in the intense threat environment projected for the 1990's. The UTCS has an architecture of independent trajectory generation elements whose operations are integrated by a knowledge-based system. This artificial intelligence (AI) technique utilizes production rules, an interface engine, and a system of frames for communicating with the trajectory generation elements. Author

**N88-10812#** Royal Aircraft Establishment, Farnborough (England).
**TOWARDS THE UNMANNED COCKPIT** **c05**
Brian Ellis *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

Trends in air warfare make the development of autonomous unmanned aircraft necessary. Advances in intelligent knowledge-based systems (IKBS) and in computing technology will make it possible. The case for unmanned aircraft and their probable evolution is made. Some indications are offered of the developments that will be called for in the IKBS themselves and in the computing hardware. Author

**N88-10813#** Centre de Recherches de la Compagine Generale d'Electricite, Marcoussis (France).
**GENERATING DIAGNOSTIC KNOWLEDGE FROM A STRUCTURAL AND FUNCTIONAL DESCRIPTION** **c63**
Jean-Pascal Aubert, Jean-Michel Cornille, and Alain Meller *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 4 p Sponsored by French Defense Ministry (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

The problem of diagnostic knowledge acquisition is discussed. A front-end to a diagnostic system under development that provides aids to the expert in the process of diagnosis rules design is presented. This front-end uses structural and functional modeling. It is thought to be general enough to be applied to other applications. Author

**N88-10814#** Lear Siegler, Inc., Grand Rapids, Mich. Instrument and Avionic Systems Div.
**A REVIEW OF THE KNOWLEDGE ENGINEERING PROCESS** **c63**
Michael W. Bird *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

An overview of all parts of the knowledge engineering process is given. The basic types of data structures used for representing knowledge in an expert system are described, including production rules and frames. The computer based tools available for assisting engineers in acquiring and testing knowledge bases are discussed. Also covered is the validation of expert systems. Author

**N88-10815#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugfuehrung.
**A RULE-BASED SYSTEM FOR ARRIVAL SEQUENCING AND SCHEDULING IN AIR TRAFFIC CONTROL** **c04**
U. Voelckers *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

A rule based system is presented that is designed to assist human controllers in efficiently merging high density inbound traffic into congested airports. The rationale for the design of a rule based system and the critical requirements for the development of a rule based system for application to air traffic control are discussed. The system uses the OPS5 production system and is programmed in FRANZ LISP with embedded C functions. The system still has limited capabilities. Author

**N88-10816#** Electronique Serge Dassault, St. Cloud (France).
**HOW TO USE PROLOG FOR EXPERT SYSTEM PROGRAMMING** **c61**
Michel Muenier, Patrick Taillibert, and Serge Varennes *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 8 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

A description is given of how PROLOG is used to develop expert systems. It is shown that PROLOG had to be extended towards an object oriented representation. The basic mechanisms that should occur in such a representation to make expert programming easier are discussed. The EMICAT (MI4) environment, constructed on this PROLOG extension so that knowledge can be represented and used in the form of production rules, is described. The implimentation of this environment is briefly described. Author

**N88-10817#** Carleton Univ., Ottawa (Ontario). Dept. of Systems and Computer Engineering.
**REAL-TIME EXPERT SYSTEMS: A STATUS REPORT** **c61**
B. A. Bowen *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 15 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

The control algorithm for complex physical plants is usually based on a model, either discrete or linear, which describes the appropriate response to data obtained from sensors located throughout the plant. Models of plant behavior are usually based on a Markov process assumption or on some linear system approximation. Many subtle characteristics beyond the range of the assumptions or approximations are either ignored or the appropriate response is obtained by fine-tuning after the control system is installed. A comprehensive state-of-the-art summary of the status, progress, issues and directions in the use of knowledge-based systems in real-time control applications is given. Author

**N88-10818*#** National Aeronautics and Space Administration, Washington, D.C.
**INVESTIGATION OF CONTROL LAW FOR ACTIVE FLUTTER SUPPRESSION**
Weipeng Wang, Zhongquan Gu, and Demao Zhu Nov. 1987 18 p Transl. into ENGLISH from Acta Aeronautica et Astronautica Sinica, People's Republic of China, v. 7, Dec. 1986 p 566-574 Original language document was announced in IAA as A87-29607 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Prepared by Nanjing Aeronautical Coll., People's Republic of China
(Contract NASw-4005)
(NASA-TT-20126; NAS 1.77:20126) Avail: NTIS HC A03/MF A01 CSCL 01C

Discussed is the technology of active flutter suppression research by the use of the wind-tunnel model of a delta wing with low aspect ratio. The research includes the establishment of a mathematical model for the servo-aeroelastic system, and the synthesis and analysis of sub-optimal output feedback control laws for active flutter suppression. Author

# 09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

No abstracts in this category.

# 12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

**N88-10819*#** National Academy of Sciences - National Research Council, Washington, D. C. Committee on Advanced Space Technology.
**SPACE TECHNOLOGY TO MEET FUTURE NEEDS**
1987 183 p Original contains color illustrations
(Contract NASw-4003)
(NASA-CR-181473; NAS 1.26:181473) Avail: NTIS HC A09/MF A01 CSCL 22A

Key technologies were identified where contemporary investments might have large payoffs in technological options for the future. The future needs were considered for space transportation, space science, national security, and manned missions. Eight areas were selected as being vital for the national future in space. Findings regarding representative mission and the recommendations concerning high priority technologies are summarized. B.G.

# 13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

**N88-10820#** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
**PRECISE ORBIT COMPUTATION, GRAVITY MODEL ADJUSTMENT AND ALTIMETER DATA PROCESSING FOR THE ERS-1 ALTIMETRY MISSION**
K. F. Wakker, B. A. C. Ambrosius, R. C. A. Zandbergen, and G. H. M. vanGeldorp Paris, France ESA Feb. 1987 295 p
(Contract ESA-6140/84-D-IM)
(ESA-CR(P)-2436; ETN-87-90892) Avail: NTIS HC A13/MF A01

The ERS-1 and Seasat (which has a similar orbit) ground track patterns and ground systems tracking coverage; Earth gravity field models; radial orbit perturbations due to specific terms of these models; and the concept of super-tailored gravity models are discussed. Six 3-day laser range data arcs of Seasat were selected. Accurate reference orbits were computed as a truth model to which orbits computed with three super-tailored gravity models and orbits computed from a combination of laser and altimeter measurements are compared. Techniques to process altimeter measurements for the determination of regional mean sea surfaces, the measurement of smallscale features of the geoid, and the detection of mesoscale temporal variabilities of the sea surface are considered. A 3 day repeat has insufficient spatial resolution for sea surfaces, 10 days is recommended. ESA

# 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

**N88-10840*#** Pittsburgh-Des Moines Steel Co., Pa.
**MEETING TODAY'S REQUIREMENTS FOR LARGE THERMAL VACUUM TEST FACILITIES**
R. L. Corinth and J. A. Rouse (CVI, Inc., Columbus, Ohio.) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 112-130 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10841*#** Rockwell International Corp., Canoga Park, Calif.
**A MODERN SPACE SIMULATION FACILITY TO ACCOMMODATE HIGH PRODUCTION ACCEPTANCE TESTING Abstract Only**
J. D. Glover *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 131 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10843*#** CBI Industries, Inc., Oak Brook, Ill.
**MOBILE TEST FIXTURE SYSTEM FOR USE IN A THERMAL VACUUM FACILITY**
Ronald C. Weber, Robert E. Stoyer, and Warren A. Carpenter *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 149-162 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10849*#** Leybold-Heraeus G.m.b.H., Hanau/Main (West Germany).
**CHARACTERISTICS AND PERFORMANCE OF THE ESTEC LARGE SPACE SIMULATOR CRYOGENIC SYSTEM**
H. Amlinger and S. J. Bosma (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 236-247 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10850*#** Liege Univ. (Belgium).
**TEST OF THE HIPPARCOS PAYLOAD IN THE LIEGE VACUUM FACILITY FOCAL Abstract Only**
C. Jamar, A. Cucchiard, J. Jamar, D. Macau-Hercot, J. P. Camus,

D. Dubet, and J. P. Macau *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 248 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10852*#** Zeiss (Carl), Oberkochen (West Germany).
**DESIGN CONCEPTS TO IMPROVE HIGH PERFORMANCE SOLAR SIMULATOR**
H. J. Juranek and H. U. Frey (Industrienlagen-Betriebsgesellschaft m.b.H., Munich, West Germany ) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 256-274 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10855*#** European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
**A NEW TYPE OF LAMP AND REFLECTOR FOR I.R. SIMULATION**
G. Saenger *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 286-311 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10878*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**RESEARCH AND DEVELOPMENT AT THE MARSHALL SPACE FLIGHT CENTER NEUTRAL BUOYANCY SIMULATOR**
Vygantas P. Kulpa *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 142-152 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 14B

# 15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

**N88-10821#** Loughborough Univ. of Technology (England). Dept. of Transport Technology.
**A STUDY INTO THE EFFECTS AND VIABILITY OF APPLYING LATERAL FORCE CONTROL TO AN AIR TO GROUND ROCKET M.S. Thesis**
J. C. Halsey 1987 77 p
(ETN-87-90925) Avail: NTIS HC A05/MF A01

The effects of lateral force control on a previously unguided air to ground rocket were studied. A 5 deg aiming cone was required. The firing of masses out of the side of the rocket, to give a sideways impulse and the emission of a lateral jet to push the rocket across were analyzed. The disturbance of the flow on thrust position was changed by 9% or 12% with respect to the center of gravity. Lateral force control is shown to be feasible.
ESA

**N88-10822#** Loughborough Univ. of Technology (England). Dept. of Electrical and Electronic Engineering.
**A STUDY OF INFRARED MISSILE SEEKERS AND THE COUNTERMEASURE TECHNIQUES EMPLOYED TO DEFEAT THEM M.S. Thesis**
R. I. Allan 1987 104 p
(ETN-87-90927) Avail: NTIS HC A06/MF A01

The surface-to-air engagement scenario is analyzed to illustrate the operation of an IR missile. The function of a guided missile is defined and the basic aerodynamic characteristics of a missile are discussed. The implications of the missile's propulsion unit, drag, and controls are presented. The basic principles of guidance are reviewed, concentrating on homing guidance. Reticle, image scanning, and focal plane array seekers are reviewed. Decoys, smoke, clouds, modulated jammers, destruction, tactical maneuvering, and radiation shielding countermeasures are summarized.
ESA

# 16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

**N88-10823*#** Rockwell International Corp., Downey, Calif. Space Transportation Systems Div.
**AERODYNAMIC DESCRIPTION AND DATA USAGE, VOLUME 1**
Sep. 1985 388 p
(Contract NAS9-14000)
(NASA-CR-172019; NAS 1.26:172019; STS85-0118-Vol-1; IRD-SE-640D-E-Vol-1; WBS-10-Vol-1; WBS-14-Vol-1) Avail: NTIS HC A17/MF A01 CSCL 22B

The Space Shuttle Vehicle, its mission, evolution, geometry, systems, and the use of the data given in the remaining volumes are described.
B.G.

**N88-10824*#** Rockwell International Corp., Downey, Calif. Space Transportation Systems Div.
**OPERATIONAL AERODYNAMIC DATA BOOK. VOLUME 3: ORBITER VEHICLE AERODYNAMIC DATA, PART 2**
Sep. 1985 710 p
(Contract NAS9-14000)
(NASA-CR-172022; NAS 1.26:172022; STS85-0118-Vol-3-Pt-2; IRD-SE-640-D-E-Vol-3-Pt-2; WBS-10-Vol-3-Pt-2; WBS-14-Vol-3-Pt-2) Avail: NTIS HC A99/MF E03 CSCL 22B

Part 2 of Volume 3 of the Operational Aerodynamic Data Book for the Space Shuttle discusses yawing moments. The orbital and entry aerodynamic and RCS yawing moment data are presented. The aerodynamic coefficient data are presented in three forms: (1) on-orbit, payload bay doors open for use for on-orbit station keeping aerodynamics; (2) on-orbit, payload bay doors closed for use for on-orbit station keeping and TAL abort; and (3) for nominal entry, TAL, AOA, GRTLS, and AFO aborts. The orbital and entry RCS data are contained in Item 3 of the aerodynamic data, and are to be used in conjunction with Items 1 and 2. The RCS data are defined in terms of impingement and interaction.
Author

**N88-10825*#** Rockwell International Corp., Downey, Calif. Space Transportation Systems Div.
**OPERATIONAL AERODYNAMIC DATA BOOK. VOLUME 3: ORBITER VEHICLE AERODYNAMIC DATA**
W. R. Russell, ed. Sep. 1985 687 p
(Contract NAS9-14000)
(NASA-CR-172021; NAS 1.26:172021; STS85-0118-Vol-3-Pt-1; IRD-SE-640D-E-Vol-3-Pt-1; WBS-10-Vol-3-Pt-1; WBS-14-Vol-3-Pt-1) Avail: NTIS HC A99/MF E03 CSCL 22B

Volume 3 of the Operational Aerodynamic Data Book provides the primary reference work for all Orbiter Vehicle aerodynamic data appropriate to full-scale flight performance, stability, and control analyses. This volume is to be used together with Volume 1, which provides the mission description, geometry, systems descriptions, and the equations for calculation and use of the aerodynamic data presented herein. Volume 3 contains the aerodynamic force and moment coefficients (both static and dynamic), control effectiveness, control surface aerodynamic hinge moments, and aerodynamic data uncertainties. The effects of aeroelastic deformation and reaction control flow field interactions are also provided. Data are provided throughout the entry speed-altitude flight regimes as well as on-orbit, and are predicted on the results of wind tunnel tests of the Orbiter Vehicle, on

analytical methods, and on flight data extracted from the Space Transportation System Flight Program. Author

**N88-10826*#** Rockwell International Corp., Downey, Calif. Space Transportation Systems Div.
**OPERATIONAL AERODYNAMIC DATA BOOK. VOLUME 2: LAUNCH VEHICLE AERODYNAMIC DATA**
W. R. Russell, ed. Sep. 1985 667 p
(Contract NAS9-14000)
(NASA-CR-172023; NAS 1.26:172023; STS85-0118-Vol-2-Pt-1; IRD-SE-640D-E-Vol-2-Pt-1; WBS-10-Vol-2-Pt-1; WBS-14-Vol-2-Pt-1) Avail: NTIS HC A99/MF A01 CSCL 22B

Volume 2 of the Operational Aerodynamic Data Book provides the primary reference work for all Launch Vehicle aerodynamic data appropriate to full-scale flight performance, stability, and control analyses. This volume is to be used along with Volume 1, which provides the mission description and capability, geometry, systems descriptions, and the equations for calculation and use of the aerodynamic data presented herein. Volume 2 contains the aerodynamic force and moment coefficients (both static and dynamic), control effectiveness, pertinent aerodynamic hinge moments, and aerodynamic data uncertainties. Wing and Vertical Tail root shear, bending and torsion are also presented. Data are provided throughout the launch speed-altitude flight regimes for the two stages of the launch configuration as well as data for both normal and abort separation of the various elements. The effects of aeroelastic deformation and reaction control flow field interactions are also provided. Data are predicted on the results of wind tunnel tests of various scale models of the mated vehicle and its elements and on flight test data extracted from the Space Transportation System Flight Test Program. Author

**N88-10827*#** Rockwell International Corp., Downey, Calif. Space Transportation Systems Div.
**OPERATIONAL AERODYNAMIC DATA BOOK. VOLUME 2: LAUNCH VEHICLE AERODYNAMIC DATA, PART 2**
Sep. 1985 711 p
(Contract NAS9-14000)
(NASA-CR-172020; NAS 1.26:172020; STS85-0118-Vol-2-Pt-2; IRD-SE-640D-E-Vol-2-Pt-2; WBS-10-Vol-2-Pt-2; WBS-14-Vol-2-Pt-2) Avail: NTIS HC A99/MF E03 CSCL 22B

The aerodynamic data for the launch configuration, including separation of the three elements and abort situations are given. Presented in tabular form are the results for pitching moments, side force, right hand elevon and wing panel loads, rolling moments, and vertical tail loads. B.G.

**N88-10834*#** Lockheed Space Operations Co., Cocoa Beach, Calif.
**CONTAMINATION CONTROL OF THE SPACE SHUTTLE ORBITER CREW COMPARTMENT**
Donald W. Bartelson *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 61-62 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

**N88-10837*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**REDISTRIBUTION OF PARTICULATES IN SHUTTLE BAY DURING LAUNCH**
John J. Scialdone *In its* Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 66-72 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

# 17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

No abstracts in this category.

# 18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

**N88-10828*#** Ball Aerospace Systems Div., Boulder, Colo.
**PHASE 3 STUDY OF SELECTED TETHER APPLICATIONS IN SPACE. VOLUME 2: STUDY RESULTS Final Report**
Dec. 1986 196 p
(Contract NAS8-36617)
(NASA-CR-179186; NAS 1.26:179186; DPD-665-Vol-2; DR-4-Vol-2) Avail: NTIS HC A09/MF A01 CSCL 22B

Engineering designs were developed relative to a tethered launch assist from the Shuttle for payloads up to 10,000 kg mass and the tethering of a 15,000 kg science platform from the space station. These designs are used for a cost benefit analysis which assesses the feasibility of using such systems as a practical alternative to what would otherwise be accomplished by conventional means. The term conventional as related to both these applications is intended to apply to the use of some form(s) of chemical propulsion system. B.G.

**N88-10829*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**FOURTEENTH SPACE SIMULATION CONFERENCE: TESTING FOR A PERMANENT PRESENCE IN SPACE**
Joseph L. Stecher, III, ed. 1986 435 p Conference held in Baltimore, Md., 3-6 Nov. 1986; sponsored by NASA, Inst. of Environmental Sciences, AIAA, and the American Society for Testing and Materials
(NASA-CP-2446; Rept-86B0561; NAS 1.55:2446) Avail: NTIS HC A19/MF A01 CSCL 22B

The Institute of Environmental Sciences Fourteenth Space Simulation Conference, Testing for a Permanent Presence in Space, provided participants a forum to acquire and exchange information on the state-of-the-art in space simulation, test technology, thermal simulation, and protection, contamination, and techniques of test measurements. For individual titles, see N88-10830 through N88-10865.

**N88-10830*#** Centre National d'Etudes Spatiales, Toulouse (France).
**INFRA-RED LAMP PANEL STUDY AND ASSESSMENT APPLICATION TO THERMAL VACUUM TESTING OF SIGMA TELESCOPE c89**
Jacques Mauduyt, Joseph Merlet, and Christiane Poux (Intespace, Toulouse, France ) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 1-14 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 03A

A research and development program of the Infra-Red Test has been conducted by the French Space Agency (CNES). A

choice, after characterization, among several possibilities has been made on the type of methods and facilities for the I.R. test. An application to the Thermal Vacuum Test of the SIGMA Telescope is described. Author

**N88-10831*#** Spar Aerospace Ltd., Ste-Anne-de-Bellevue (Quebec).
**MONITORED BACKGROUND RADIOMETER c35**
C. Ruel, M. Larouche, and M. Donato *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 15-26 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

The infrared (IR) testing of the Olympus thermal model has provided a capability to perform cost effective thermal balance testing of satellites and satellite components. A high-accuracy monitored background radiometer was developed for the measurement of absorbed radiation heat flux encountered during IR thermal vacuum testing of spacecraft. The design, development, and calibration of this radiometer is described. Author

**N88-10832*#** McDonnell-Douglas Astronautics Co., St. Louis, Mo.
**ROCKET NOZZLE THERMAL SHOCK TESTS IN AN ARC HEATER FACILITY c20**
James H. Painter and Ronald A. Williamson *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 27-41 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 21H

A rocket motor nozzle thermal structural test technique that utilizes arc heated nitrogen to simulate a motor burn was developed. The technique was used to test four heavily instrumented full-scale Star 48 rocket motor 2D carbon/carbon segments at conditions simulating the predicted thermal-structural environment. All four nozzles survived the tests without catastrophic or other structural failures. The test technique demonstrated promise as a low cost, controllable alternative to rocket motor firing. The technique includes the capability of rapid termination in the event of failure, allowing post-test analysis. Author

**N88-10833*#** New Jersey Inst. of Tech., Newark.
**RADIATIVE AND FREE-CONVECTIVE HEAT TRANSFER FROM A FINITE HORIZONTAL PLATE INSIDE AN ENCLOSURE c34**
Peter Hrycak and D. J. Sandman *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 42-60 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20D

An experimental and analytical investigation of heat transfer from a horizontal, thin, square plate inside of an enclosure was carried out. Experimental results were obtained from both the upward-facing and the downward-facing sides of the heated plate. Starting with the integrated momentum and energy equations, approximate solutions were obtained for heat transfer in the laminar and the turbulent regime that correlate well with experimental data. Radiative heat transfer correction was given special attention. Effects of the enclosure-related recirculation of the test fluid, as well as effects of simultaneous heat transfer on both sides of the plate, caused an early transition, and indicated a high level of internal turbulence. Author

**N88-10834*#** Lockheed Space Operations Co., Cocoa Beach, Calif.
**CONTAMINATION CONTROL OF THE SPACE SHUTTLE ORBITER CREW COMPARTMENT c16**
Donald W. Bartelson *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 61-62 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

Effective contamination control as applied to manned space flight environments is a discipline characterized and controlled by many parameters. An introduction is given to issues involving Orbiter crew compartment contamination control. An effective ground processing contamination control program is an essential building block to a successful shuttle mission. Personnel are required to don cleanroom-grade clothing ensembles before entering the crew compartment and follow cleanroom rules and regulations. Prior to crew compartment entry, materials and equipment must be checked by an orbiter integrity clerk stationed outside the white-room entrance for compliance to program requirements. Analysis and source identification of crew compartment debris studies have been going on for two years. The objective of these studies is to determine and identify particulate generating materials and activities in the crew compartment. Results show a wide spectrum of many different types of materials. When source identification is made, corrective action is implemented to minimize or curtail further contaminate generation. Author

**N88-10835*#** Boeing Co., Seattle, Wash.
**USE OF A 35mm CAMERA FOR REMOTE SURFACE CLEANLINESS VERIFICATION Abstract Only c35**
E. R. Crutcher *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 63 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

Non-contact or remote monitoring of surfaces for both particle and molecular contaminants is required for verification of surface cleanliness on many program subsystems. The capability of a 35mm camera to satisfy this need is presented. The many limitations imposed by standard available lens systems are compared to actual required sensitivities. Methods of optimizing camera systems for specific applications and descriptions of support systems for extending the range of usefulness of the recorded data are also provided. Although this general concept is not new, significant improvements in the technique involving the use of polarized light and diffraction effects have resulted in a more efficient utilization of information recorded on the film. Author

**N88-10836*#** National Aeronautics and Space Administration, Washington, D.C.
**AN INVESTIGATION OF THE BEHAVIOR OF OUTGASSED MOLECULES IN THERMAL VACUUMS c72**
W. Mahone, R. Kays (Lockheed Engineering and Management Services Co., Inc., Las Cruces, N. Mex.), and S. Koontz *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 64-65 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20H

The objective is to understand how surfaces outgas and how outgassed substances subsequently condense on other surfaces. Preliminary tests produced calculated mass losses that were found to be in reasonable agreement with mass losses determined by weighing the sample before and after testing on analytical balances. However, using test materials with various molecular properties showed characteristic variations in the ratios of calculated total mass loss to experimental loss. These variations indicate that for some molecules energetic barriers to absorption and desorption can exist between outgassed molecules and the surfaces on which they condense. Author

**N88-10837*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**REDISTRIBUTION OF PARTICULATES IN SHUTTLE BAY DURING LAUNCH c16**
John J. Scialdone *In its* Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 66-72 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

The dislodgement, venting, and redeposition of particles on a surface in the shuttle bay by the vibroacoustic, gravitational, and

aerodynamic forces present during shuttle ascent were investigated. The particles of different sizes which are displaced, vented, and redistributed were calculated. An estimate of the increased number of particles on certain surfaces and the decrease on others is indicated. The average sizes, velocities, and length of time for certain particles to leave the bay following initial shuttle doors opening and thermal tests were calculated based on indirect data obtained during several shuttle flights. Author

**N88-10838*#** Quadrex HPS, Inc., Gainesville, Fla.
**SHEAR STRESS CLEANING FOR SURFACE DEPARTICULATION**
R. P. Musselman and T. W. Yarbrough *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 73-94 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

A cleaning technique widely used by the nuclear utility industry for removal of radioactive surface contamination has proven effective at removing non-hazardous contaminant particles as small as 0.1 micrometer. The process employs a controlled high velocity liquid spray inside a vapor containment enclosure to remove particles from a surface. The viscous drag force generated by the cleaning fluid applies a shear stress greater than the adhesion force that holds small particles to a substrate. Fluid mechanics and field tests indicate general cleaning parameters. Author

**N88-10839*#** Helium Leak Testing, Inc., Northridge, Calif.
**VACUUM PUMPS AND SYSTEMS: A REVIEW OF CURRENT PRACTICE** **c37**
Stuart Giles *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 95-11 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 13I

A review of the fundamental characteristics of the many types of vacuum pumps and vacuum pumping systems is given. The optimum pumping range, relative cost, performance limitations, maintenance problems, system operating costs and similar subjects are discussed. Experiences from the thin film deposition, chemical processing, material handling, food processing and other industries, as well as space simulation are used to support conclusions and recommendations. Author

**N88-10840*#** Pittsburgh-Des Moines Steel Co., Pa.
**MEETING TODAY'S REQUIREMENTS FOR LARGE THERMAL VACUUM TEST FACILITIES** **c14**
R. L. Corinth and J. A. Rouse (CVI, Inc., Columbus, Ohio.) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 112-130 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

The Lockheed Thermal Vacuum Facility at Sunnyvale, California, completed in late 1986, one of the largest multi-program facilities constructed to date is described. The horizontal 12.2 m diameter by 24.4 m long chamber has removable heads at each end and houses a thermal shroud providing a test volume 10.4 m diameter by 24.4 m long. The chamber and thermal shroud are configured to permit the insertion of a 6.1 m wide by 24.4 m long vibration isolated optical bench. The pumping system incorporates an internal cryopumping array, turbomolecular pumps and cryopumps to handle multi-program needs and ranges of gas loads. The high vacuum system is capable of achieving clean, dry and empty pressures below 1.3 times 10 to the minus 6 power Pa (10 to the minus 8 power torr.) Author

**N88-10841*#** Rockwell International Corp., Canoga Park, Calif.
**A MODERN SPACE SIMULATION FACILITY TO ACCOMMODATE HIGH PRODUCTION ACCEPTANCE TESTING Abstract Only** **c14**
J. D. Glover *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 131 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

A space simulation laboratory that supports acceptance testing of spacecraft and associated subsystems at throughput rates as high as nine per year is discussed. The laboratory includes a computer operated 27' by 30' space simulation, a 20' by 20' by 20' thermal cycle chamber and an eight station thermal cycle/thermal vacuum test system. The design philosophy and unique features of each system are discussed. The development of operating procedures, test team requirements, test team integration, and other peripheral activation details are described. A discussion of special accommodations for the efficient utilization of the systems in support of high rate production is presented. Author

**N88-10842*#** Aeritalia S.p.A., Rome (Italy).
**COLUMBUS PRESSURIZED MODULE VERIFICATION**
Piero Messidoro and Emanuele Comandatore *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 132-148 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

The baseline verification approach of the COLUMBUS Pressurized Module was defined during the A and B1 project phases. Peculiarities of the verification program are the testing requirements derived from the permanent manned presence in space. The model philosophy and the test program have been developed in line with the overall verification concept. Such critical areas as meteoroid protections, heat pipe radiators and module seals are identified and tested. Verification problem areas are identified and recommendations for the next development are proposed. Author

**N88-10843*#** CBI Industries, Inc., Oak Brook, Ill.
**MOBILE TEST FIXTURE SYSTEM FOR USE IN A THERMAL VACUUM FACILITY** **c14**
Ronald C. Weber, Robert E. Stoyer, and Warren A. Carpenter *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 149-162 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

A turnkey thermal vacuum facility is discussed. A system is described that integrates five major subsystems including the transporters, multiplexers, a thermal shrouded test fixture, a thermal isolation system and an internal utility distribution system into a mobile test fixture system. This concept allows the spacecraft to be mounted outside of the chamber. Instrumentation and checkout of the spacecraft and its instrumentation is accomplished at this station. The spacecraft, which is still mated to the test fixture, is then moved into the chamber using an air transporter system. Author

**N88-10844*#** Reliance Electric Co., Worthington, Ohio.
**MOVING THE FACTORY INTO ORBIT**
Robert Dannenfelser, Jr. *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 163-174 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

Prompted by the attention focused on the Space Shuttle Program's cost and safety problems and the publicity surrounding the intended U.S. space station, a review is given of the status of efforts being made to use space as a commercial manufacturing environment. Author

**N88-10845*#** Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
**SURVEILLANCE SYSTEMS TEST AND EVALUATION FACILITIES**
Jere J. Matty and Ronald Dawbarn (Calspan Field Services, Inc., Arnold AFS, Tenn.) *In* NASA- Goddard Space Flight Center,

Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 175-192 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

In January of 1983, a team was formed to explore test methodologies and test facility concepts required to meet the needs of space-based surveillance systems. The output of this study was a road map of test methodologies and test facilities that will aid the development of this country's critical space-based sensor assets. A condensation of those results is given. Author

**N88-10846*#** Dayton Univ., Ohio.
**MATHEMATICAL MODELLING OF SOLAR ULTRAVIOLET RADIATION INDUCED OPTICAL DEGRADATION IN ANODIZED ALUMINUM** **c26**
John D. Ruley *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 193-208 (For primary document see N88-10829 02-18)
(Contract F33615-84-C-5130)
Avail: NTIS HC A19/MF A01 CSCL 11F

In the design of spacecraft for proper thermal balance, accurate information on the long-term optical behavior of the spacecraft outer skin materials is necessary. A phenomenological model for such behavior is given. The underlying principles are explained and some examples are given of the model's fit to actual measurements under simulated Earth-orbit conditions. Comments are given on the applicability of the model to materials testing and thermal modelling. Author

**N88-10847*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**HIGH INTENSITY 5 eV O-ATOM EXPOSURE FACILITY FOR MATERIAL DEGRADATION STUDIES** **c25**
J. B. Cross, L. H. Spangler, M. A. Hoffbauer, F. A. Archuleta, Lubert Leger, James Visentine, and Don E. Hunton (Air Force Geophysics Lab., Hanscom AFB, Mass.) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 209-226 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 07D

An atomic oxygen exposure facility was developed for studies of material degradation. The goal of these studies is to provide design criteria and information for the manufacture of long life (20 to 30 years) construction materials for use in low Earth orbit. The studies that are being undertaken will provide: (1) absolute reaction cross sections for the engineering design problems, (2) formulations of reaction mechanisms for use in the selection of suitable existing materials and the design of new more resistant ones, and (3) the calibration of flight hardware (mass spectrometers, etc.) in order to directly relate experiments performed in low Earth orbit to ground based investigations. The facility consists of a CW laser sustained discharge source of O-atoms, an atomic beam formation and diagnostics system, a spinning rotor viscometer, and provision for using the system for calibration of actual flight instruments. Author

**N88-10848*#** Tennessee Technological Univ., Cookeville.
**RAPID TOXICITY DETECTION IN WATER QUALITY CONTROL UTILIZING AUTOMATED MULTISPECIES BIOMONITORING FOR PERMANENT SPACE STATIONS** **c51**
E. L. Morgan, R. C. Young, M. D. Smith (Tennessee Valley Authority, Knoxville.), and K. W. Eagleson *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 227-235 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 06B

The objective of this study was to evaluate proposed design characteristics and applications of automated biomonitoring devices for real-time toxicity detection in water quality control on-board permanent space stations. Simulated tests in downlinking transmissions of automated biomonitoring data to Earth-receiving stations were simulated using satellite data transmissions from remote Earth-based stations. Author

**N88-10849*#** Leybold-Heraeus G.m.b.H., Hanau/Main (West Germany).
**CHARACTERISTICS AND PERFORMANCE OF THE ESTEC LARGE SPACE SIMULATOR CRYOGENIC SYSTEM** **c14**
H. Amlinger and S. J. Bosma (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 236-247 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

The final concept and performance characteristics of the Large Space Simulator (LSS) at ESTEC, The Netherlands are discussed. The LSS cryogenics system has proven its operational capabilities under simulated heat load conditions and provides sufficient margin for future elevated requirements. The acceptance test proved that nominal operating pressures can be lower than the design parameters, providing increased system safety and reliability. The ease of access for repair and the incorporated redundancy will limit system downtime. Finally, the system design resulted in a low consumption of LN sub 2, which is an important factor in keeping the operational costs at a low level. Author

**N88-10850*#** Liege Univ. (Belgium).
**TEST OF THE HIPPARCOS PAYLOAD IN THE LIEGE VACUUM FACILITY FOCAL Abstract Only** **c14**
C. Jamar, A. Cucchiard, J. Jamar, D. Macau-Hercot, J. P. Camus, D. Dubet, and J. P. Macau *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 248 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

The Liege thermal vacuum optical bench (FOCAL) was used to control the mechanical stability of the structure of the European Space Agency's HIPPARCOS astrometry payload. The payload is designed to measure angles of .001 arcsec between stars during 2.5 years and this accuracy can only be reached with the extreme stability of the device. The structure of the payload is made of carbon fiber; it is thermally stabilized with an accuracy of .01 degrees C. During the test, the payload is enclosed in a shell made of shrouds having a geometry close to the shading structure of the spacecraft. The shroud temperatures are defined by the conditions in orbit, e.g., the spacecraft is spinning in front of the Sun with a period of two hours and the temperature of the shrouds is cycled around the payload with a 2 hour period. In order to avoid disturbances by vibrations, the payload is put on an adapter interfaced with the optical bench and the seismic block; the shrouds are supported by a carrier with no direct interface with the table. This method avoids perturbances brought about by the cooling fluid of the shrouds. Author

**N88-10851*#** Aerospace Corp., El Segundo, Calif.
**THE COMBINED RELEASE AND RADIATION EFFECTS SATELLITE, A JOINT NASA/DOD PROGRAM**
D. J. Berrier *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 249-255 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

The Combined Release and Radiation Effects Satellite (CRRES) program is a two-phase joint USAF/NASA program consisting of a low Earth orbit (LEO) phase and a geosynchronous transfer orbit (GTO) phase. The mission has been carefully planned to help clarify the geospace environment picture and its effects on space hardware, communications, and man. CRRES instruments were selected for synergism, accuracy, and applicability, and will be cross-calibrated for consistency. They will provide data to fill the gaps in geospace modeling data already obtained, and will update and correct existing models. The chemical release experiments and low altitude instruments will clarify the character

of the ionosphere in low Earth orbit and the high altitude chemical release experiments will improve knowledge of how trapped particle populations behave out as far as synchronous altitudes. The ionospheric studies will lead to significantly improved Earth-space intercommunications. Author

**N88-10852*#** Zeiss (Carl), Oberkochen (West Germany).
**DESIGN CONCEPTS TO IMPROVE HIGH PERFORMANCE SOLAR SIMULATOR** **c14**
H. J. Juranek and H. U. Frey (Industrienlagen-Betriebsgesellschaft m.b.H., Munich, West Germany ) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 256-274 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

By improving several important components of the well known off-axis solar simulator system, a considerable step forward was made. The careful mathematical studies on the optics and the thermal side of the problem lead to a highly efficient system with low operational costs and a high reliability. The actual performance of the simulator is significantly better than the specified one, and the efficiency is outstanding. No more than 12 lamps operating at 18 kW are required to obtain one Solar Constant in the 6 m beam. It is now known that by using sophisticated optics, even larger facilities of high performance can be designed without leaving the proven off-axis concept and using a spherical mirror. Using high performance optics is a means of reducing costs at a given size of beam because the number of lamps is one of the most cost driving factors in the construction of a solar simulator. Author

**N88-10853*#** Rockwell International Corp., Canoga Park, Calif.
**EVALUATION AND CERTIFICATION OF HEATER ASSEMBLIES DEVELOPED FOR THERMAL VACUUM ACCEPTANCE TESTING Abstract Only** **c37**
J. E. Allen *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 275 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 13I

Preparation of Rockwell International's Thermal Vacuum Chamber for acceptance testing of a mass produced satellite required the development of unique quartz lamp and hot wire heater assemblies. Testing performed on the basic elements of these heaters is described, as is the final testing done to certify that the heater assemblies meet the thermal requirements for acceptance testing. The methods and procedures of thermal mapping used during the development and final certification of these heater assemblies are presented. The absence of a definitive standard for determining flux distribution and heating boundaries for heaters of this type required the development of a test plan incorporating several thermal mapping techniques. These techniques include the development of heat flux using a multiple calorimeter array for both vacuum and ambient test conditions, and a photographic method for detecting heating boundaries. The test plan and thermal mapping techniques are discussed. Author

**N88-10854*#** Massachusetts Inst. of Tech., Lexington.
**THERMAL TESTING BY INTERNAL IR HEATING OF THE FEP MODULE**
D. M. Nathanson, R. A. Efromson, and E. I. Lee *In* NASA-Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 276-285 Sponsored in part by AF (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

A spacecraft module, to be integrated with the FLTSATCOM spacecraft, was tested in a simulated orbit environment separate from the host spacecraft. Thermal vacuum testing of the module was accomplished using internal IR heating rather than conventional external heat sources. For this configuration, the technique produced boundary conditions expected for flight to enable verification of system performance and thermal design details. Author

**N88-10855*#** European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
**A NEW TYPE OF LAMP AND REFLECTOR FOR I.R. SIMULATION** **c14**
G. Saenger *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 286-311 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

The lamps and reflectors used for infrared radiation simulation tests at ESTEC did not allow researchers to predict the intensity needed for test conditions with the desired accuracy. This was due to poor reproducibility of the polar diagrams, the unknown contribution of the radiation in the long wavelength range in vacuum, imperfections in the quartz bulbs, and misalignment of the lamp in the reflector. When using a 1000 W coiled spiral quartz lamp with a diffuse reflector, these shortcomings are overcome. Due to the good reproducibility, an overall accuracy within plus or minus 2 percent should be obtained. Author

**N88-10856*#** Spar Aerospace Ltd., Ste-Anne-de-Bellevue (Quebec).
**EVALUATION OF THE INFRARED TEST METHOD FOR THE OLYMPUS THERMAL BALANCE TESTS** **c35**
M. Donato, D. StPierre, J. Green, and M. Reeves *In* NASA-Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 312 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

The performance of the infrared (IR) rig used for the thermal balance testing of the Olympus S/C thermal model is discussed. Included in this evaluation are the rig effects themselves, the IRFLUX computer code used to predict the radiation inputs, the Monitored Background Radiometers (MBR's) developed to measure the absorbed radiation flux intensity, the Uniform Temperature Reference (UTR) based temperature measurement system and the data acquisition system. A preliminary set of verification tests were performed on a 1 m x 1 m zone to assess the performance of the IR lamps, calrods, MBR's and aluminized baffles. The results were used, in part, to obtain some empirical data required for the IRFLUX code. This data included lamp and calrod characteristics, the absorptance function for various surface types, and the baffle reflectivities. Author

**N88-10857*#** North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering.
**TRANSIENT MODELING OF THE THERMOHYDRAULIC BEHAVIOR OF HIGH TEMPERATURE HEAT PIPES FOR SPACE REACTOR APPLICATIONS** **c34**
Michael L. Hall and Joseph M. Doster *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 313-330 Sponsored in part by DOE (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20D

Many proposed space reactor designs employ heat pipes as a means of conveying heat. Previous researchers have been concerned with steady state operation, but the transient operation is of interest in space reactor applications due to the necessity of remote startup and shutdown. A model is being developed to study the dynamic behavior of high temperature heat pipes during startup, shutdown and normal operation under space environments. Model development and preliminary results for a hypothetical design of the system are presented. Author

**N88-10858*#** Hughes Aircraft Co., Fullerton, Calif.
**APPLICATIONS OF HEAT PIPES TO COOL PWBS AND HYBRID MICROCIRCUITS** **c34**
K. S. Sekhon *In* NASA- Goddard Space Flight Center, Greenbelt,

Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 331-340 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20D

Some of the advanced thermal management techniques used to reduce operating junction temperature under extreme environmental temperature conditions are discussed. Heat pipes in actual electronic packaging applications, and those under development, are discussed. Performance characteristics of heat pipes are given, and examples are described of how thermal problems in electronic packaging are solved through the use of heat pipes. Author

**N88-10859*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**SPACE STATION CONTAMINATION CONSIDERATIONS Abstract Only**
L. Leger, H. Ehlers, and S. Jacobs *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 341 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

The external induced environment generated by space station activity, or more specifically by gases, particles, and light background is discussed. These contaminant species must be controlled if sensitive systems, such as solar energy collectors or science experiments exposed to the external environment are to function properly. The requirements generally set limits on the level of gas species, matter deposited on surfaces and light background levels over various spectral regions. They also address environment monitoring and contamination controls during manufacturing. Limits on effluent release and system leakages are in turn derived from these requirements. Author

**N88-10860*#** TRW, Inc., Redondo Beach, Calif.
**CONTAMINATION CONTROL CONCEPTS FOR SPACE STATION CUSTOMER SERVICING**
K. A. Maruya, L. E. Ryan, L. A. Rosales, and E. H. Medler *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 342-366 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

The customer servicing operations envisioned for the space station, which include instrument repair, orbital replacement unit (ORU) changeout, and fluid replenishment for free-flying and attached payloads, are expected to create requirements for a unique contamination control subsystem for the customer servicing facility (CSF). Both the core space station and the CSF users present unique requirements/sensitivities, not all of which are currently defined with common criteria. Preliminary results from an assessment of the effects of the CSF-induced contamination environment are reported. Strategies for a comprehensive contamination control approach and a description of specific hardware devices and their applicability are discussed. Author

**N88-10861*#** Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
**SCENE SIMULATION FOR PASSIVE IR SYSTEMS** c74
J. D. Holt, R. Dawbarn, and A. B. Bailey (Calspan Field Services, Inc., Arnold AFS, Tenn.) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 367-382 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20F

The development of large mosaic detector arrays will allow for the construction of staring long wave infrared (LWIR) sensors which can observe large fields of view instantaneously and continuously. In order to evaluate and exercise these new systems, it will be necessary to provide simulated scenes of many moving targets against an infrared clutter background. Researchers are currently developing a projector/screen system. This system is comprised of a mechanical scanner, a diffuse screen, and a miniature blackbody. A prototype of the mechanical scanner, which is comprised of four independently driven scanners, has been designed, fabricated, and evaluated under room and cryogenic vacuum conditions. A large diffuse screen has been constructed and tested for structural integrity under cryogenic/vacuum thermal cycling. Construction techniques have been developed for the fabrication of miniature high-temperature blackbody sources. Finally, a concept has been developed to use this miniature blackbody to produce a spectrally tailorable source. Author

**N88-10862*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**SURFACE SCATTERING CHARACTERISTICS AND THE MEASUREMENT OF PARTICULATE CONTAMINATION**
Paolo A. Carosso (TS Infosystems, Lanham, Md.) and Nancy J. P. Carosso *In its* Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 383-402 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

Surface scattering measurement techniques can be adopted for use in spacecraft contamination control programs. A witness mirror measurement program was developed and implemented for the NASA Cosmic Background Explorer (COBE) spacecraft. Scattering measurements were obtained before and after a qualification level vibration test for several COBE prototype instruments. The measurements indicate that a significant amount of particle redistribution occurred during the vibration test. The methodology used and the results obtained from this monitoring program are discussed. Author

**N88-10863*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**LOW EXTRACTABLE WIPERS FOR CLEANING SPACE FLIGHT HARDWARE**
Veronica Tijerina and Frederick C. Gross *In its* Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 403-413 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 22B

There is a need for low extractable wipers for solvent cleaning of space flight hardware. Soxhlet extraction is the method utilized today by most NASA subcontractors, but there may be alternate methods to achieve the same results. The need for low non-volatile residue materials, the history of soxhlet extraction, and proposed alternate methods are discussed, as well as different types of wipers, test methods, and current standards. Author

**N88-10864*#** Rockwell International Corp., Canoga Park, Calif.
**DESIGN, CONSTRUCTION, ACTIVATION, AND OPERATION OF A HIGH INTENSITY ACOUSTIC TEST CHAMBER Abstract Only** c71
L. T. Kamei *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 414 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20A

The design philosophy, construction, integration, and activation of the high intensity acoustic test chamber for production acceptance testing of satellites are discussed. The 32,000 cubic-foot acoustic test cell consists of a steel reinforced concrete chamber with six electropneumatic noise generators. One of the innovative features of the chamber is a unique quarter horn assembly that acoustically couples the noise generators to the chamber. Design concepts, model testing, and evaluation results are presented. Considerations such as nitrogen versus compressed air source, digital closed loop spectrum control versus manual equalizers, and microprocessor based interlock systems are included. Construction difficulties, anomalies encountered, and their resolution are also discussed. Results of the readiness testing are highlighted. Author

**N88-10865*#** Orincon Corp., La Jolla, Calif.
**A DIGITAL CONTROL SYSTEM FOR HIGH LEVEL ACOUSTIC NOISE GENERATION** c71
John P. Lee and Jerry H. Bosco (Lockheed Missiles and Space Co., Sunnyvale, Calif.) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 415-426 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20A

As part of the modernization of the Acoustic Test Facility at Lockheed Missiles and Space Company, Sunnyvale, a digital acoustic control system was designed and built. The requirements imposed by Lockheed on the control system and the degree to which those requirements were met are discussed. Acceptance test results as well as some of the features of the digital control system not found in traditional manual control systems are discussed. Author

**N88-10866*#** Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
**PREDICTIVE MOMENTUM MANAGEMENT FOR A SPACE STATION MEASUREMENT AND COMPUTATION REQUIREMENTS**
John Carl Adams Aug. 1986 148 p
(Contract NAS9-17560)
(NASA-CR-172026; NAS 1.26:172026; CSDL-T-926; UPN-906)
Avail: NTIS HC A07/MF A01 CSCL 22B

An analysis is made of the effects of errors and uncertainties in the predicting of disturbance torques on the peak momentum buildup on a space station. Models of the disturbance torques acting on a space station in low Earth orbit are presented, to estimate how accurately they can be predicted. An analysis of the torque and momentum buildup about the pitch axis of the Dual Keel space station configuration is formulated, and a derivation of the Average Torque Equilibrium Attitude (ATEA) is presented, for the case of no MRMS (Mobile Remote Manipulation System) motion, Y vehicle axis MRMS motion, and Z vehicle axis MRMS motion. Results showed the peak momentum buildup to be approximately 20000 N-m-s and to be relatively insensitive to errors in the predicting torque models, for Z axis motion of the MRMS was found to vary significantly with model errors, but not exceed a value of approximately 15000 N-m-s for the Y axis MRMS motion with 1 deg attitude hold error. Minimum peak disturbance momentum was found not to occur at the ATEA angle, but at a slightly smaller angle. However, this minimum peak momentum attitude was found to produce significant disturbance momentum at the end of the predicting time interval. Author

**N88-10867*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**RECENT ADVANCES IN STRUCTURAL DYNAMICS OF LARGE SPACE STRUCTURES**
Larry D. Pinson Oct. 1987 23 p Presented at the 38th International Astronautical Federation Congress, Brighton, United Kingdom, 9-17 Oct. 1987
(NASA-TM-100513; NAS 1.15:100513) Avail: NTIS HC A03/MF A01 CSCL 22B

Recent progress in the area of structural dynamics of large space structures is reviewed. Topics include system identification, large angle slewing of flexible structures, definition of scaling limitations in structural models, and recent results on a tension-stabilized antenna concept known as the hoop-column. Increasingly complex laboratory experiments guide most of the activities leading to realistic technological developments. Theoretical progress in system identification based on system realization theory resulting in unification of several methods is reviewed. Experimental results from implementation of a theoretical large-angle slewing control approach are shown. Status and results of the development of a research computer program for analysis of the transient dynamics of large angle motion of flexible structures are presented. Correlation of results from analysis and vibration tests of the hoop-column antenna concepts are summarized. Author

**N88-10868*#** Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
**STRUCTURAL ASSEMBLY DEMONSTRATION EXPERIMENT (SADE) Final Report**
David L. Akin, Raymond A. Mills, and Mary L. Bowden 20 Jul. 1987 148 p
(Contract NAS8-34959)
(NASA-CR-179205; NAS 1.26:179205; SSL-16-87) Avail: NTIS HC A07/MF A01 CSCL 22B

The purpose of the Structural Assembly Demonstration Experiment (SADE) was to create a near-term Shuttle flight experiment focusing on the deployment and erection of structural truss elements. The activities of the MIT Space Systems Laboratory consist of three major areas: preparing and conducting neutral buoyancy simulation test series; producing a formal SADE Experiment plan; and studying the structural dynamics issues of the truss structure. Each of these areas is summarized. B.G.

**N88-10869*#** Mississippi State Univ., Mississippi State. Dept. of Electrical Engineering.
**SPACE LAB SYSTEM ANALYSIS Interim Final Report, Sep. 1986 - Sep. 1987**
F. M. Ingels and T. B. Rives 1 Oct. 1987 192 p
(Contract NAS8-36717)
(NASA-CR-179207; NAS 1.26:179207) Avail: NTIS HC A09/MF A01 CSCL 22B

An analytical analysis of the HOSC Generic Peripheral processing system was conducted. The results are summarized and they indicate that the maximum delay in performing screen change requests should be less than 2.5 sec., occurring for a slow VAX host to video screen I/O rate of 50 KBps. This delay is due to the average I/O rate from the video terminals to their host computer. Software structure of the main computers and the host computers will have greater impact on screen change or refresh response times. The HOSC data system model was updated by a newly coded PASCAL based simulation program which was installed on the HOSC VAX system. This model is described and documented. Suggestions are offered to fine tune the performance of the ETERNET interconnection network. Suggestions for using the Nutcracker by Excelan to trace itinerate packets which appear on the network from time to time were offered in discussions with the HOSC personnel. Several visits to the HOSC facility were to install and demonstrate the simulation model. Author

**N88-10870*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**SPACE CONSTRUCTION**
Jane A. Hagaman, ed. Oct. 1987 308 p Conference held in Hampton, Va., 6-7 Aug. 1986
(NASA-CP-2490; L-16378; NAS 1.55:2490) Avail: NTIS HC A14/MF A01 CSCL 22B

The purpose was to present to the aerospace community an in-depth review of Experimental Assembly of Structures on EVA (EASE)/Assembly Concept for Construction of Erectable Space Structures (ACCESS) space flight experiments and to present the status of activities regarding future space flight experiments and accompanying technology developments that will demonstrate the capability of on-orbit construction required for the Space Station. For individual titles, see N88-10871 through N88-10882.

**N88-10871*#** National Aeronautics and Space Administration, Washington, D.C.
**THE FLIGHT DEMONSTRATION PROGRAM AND SELECTION PROCESS**
G. M. Levin *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 5-12 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The Orbital Refueling System (ORS); force torque sensor; Plasma Motor/Generator (PMG) proof of function; voice controlled system; infrared intercommunications; superfluid helium on orbit transfer; laser docking sensor; and the Small Expendable Deployment System (SEDS) are summarized. B.G.

**N88-10872*#** Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
**EXPERIMENTAL ASSEMBLY OF STRUCTURES IN EVA: HARDWARE MORPHOLOGY AND DEVELOPMENT ISSUES**
Robert S. Wolf and Mary L. Bowden *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 13-30 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

A large body of data was obtained by MIT during neutral boyancy testing at Marshall Space Flight Center from 1980 to the present. These efforts, and the most significant results are summarized. The Experimental Assembly of Structure in EVA (EASE) flight experiment was undertaken to validate these results and flown on the STS 61-B in November 1985. The EASE experiment hardware is discussed and how the experiment goals dictate its size, shape, and operational characteristics, are illustrated. B.G.

**N88-10873*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**ACCESS FLIGHT HARDWARE DESIGN AND DEVELOPMENT**
John F. Rogers and Robin D. Tutterow *In its* Space Construction Oct. 1987 p 31-53 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

Several items were found to be of immense value in the design and development of the Assembly Concept for Construction of Erectable Space Structures (ACCESS) hardware. The early availability of mock-up and engineering test hardware helped to develop the concept and prove the feasibility of the experiment. The extensive neutral buoyancy testing was invaluable in developing the procedures and timelines, proving that the hardware functioned as intended, and effectively trained the astronauts. The early involvement of the crew systems/astronaut personnel was extremely beneficial in shaping the design to meet the EVA compatibility requirements. Also, the early definition of coupled loads and on-orbit dynamic responses can not be overemphasized due to the relative uncertainty in the magnitude of these loads and their impact on the design. Author

**N88-10874*#** Teledyne Brown Engineering, Huntsville, Ala.
**MISSION PECULIAR EQUIPMENT SUPPORT STRUCTURE: A PLATFORM FOR SPACE CONSTRUCTION**
Robert Hill *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 55-66 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The Space Shuttle requires carriers to support payloads in the cargo bay. As a result, the Mission Peculiar Equipment Support Structure (MPESS) was designed to carry partial payloads aboard the shuttle. The efforts to customize the MPESS for the Experimental Assembly of Structure in EVA (EASE) and Assembly Concept for Construction of Erectable Space Structure (ACCESS) experiments are summarized. B.G.

**N88-10875*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**MARSHALL SPACE FLIGHT CENTER'S ROLE IN EASE/ACCESS MISSION MANAGEMENT**
Gerald W. Hawkins *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 67-80 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The Marshall Space Flight Center (MSFC) Spacelab Payload Project Office was responsible for the mission management and development of several successful payloads. Two recent space construction experiments, the Experimental Assembly of Structures in Extravehicular Activity (EASE) and the Assembly Concept for Construction of Erectable Space Structures (ACCESS), were combined into a payload managed by the center. The Ease/ACCESS was flown aboard the Space Shuttle Mission 61-B. The EASE/ACCESS experiments were the first structures assembled in space, and the method used to manage this successful effort will be useful for future space construction missions. The MSFC mission management responsibilities for the EASE/ACCESS mission are addressed and how the lessons learned from the mission can be applied to future space construction projects are discussed. Author

**N88-10876*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**A MONOGRAPH OF THE NATIONAL SPACE TRANSPORTATION SYSTEM OFFICE (NSTSO) INTEGRATION ACTIVITIES CONDUCTED AT THE NASA LYNDON B. JOHNSON SPACE CENTER FOR THE EASE/ACCESS PAYLOAD FLOWN ON STS 61-B**
Charles Chassay *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 81-96 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The integration process of activities conducted at the NASA Lyndon B. Johnson Space Center (JSC) for the Experimental Assembly of Structures in Extravehicular activity (EASE)/Assembly Concept for Construction of Erectable Space Structures (ACCESS) payload is provided as a subset to the standard payload integration process used by the NASA Space Transportation System (STS) to fly payloads on the Space Shuttle. The EASE/ACCESS payload integration activities are chronologically reviewed beginning with the initiation of the flight manifesting and integration process. The development and documentation of the EASE/ACCESS integration requirements are also discussed along with the implementation of the mission integration activities and the engineering assessments supporting the flight integration process. In addition, the STS management support organizations, the payload safety process leading to the STS 61-B flight certification, and the overall EASE/ACCESS integration schedule are presented. Author

**N88-10877*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
**EASE/ACCESS GROUND PROCESSING AT KENNEDY SPACE CENTER**
Deborah J. Moates and Ana M. Villamil *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 97-131 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The Kennedy Space Center (KSC) Payload Management and Operations Directorate is responsible for the processing of Space Shuttle payloads. The KSC responsibilities begin prior to hardware arrival at the launch site and extend until the experiments are returned to the investigators after the flight. The KSC involvement with the integration and checkout of payloads begins with participation in experiment, Mission Peculiar Equipment (MPE), and integrated payload design reviews. This involvement also includes participation in assembly and testing of flight hardware at the appropriate design center, university, or private corporation. Once the hardware arrives at the launch site, KSC personnel install the experiments and MPE onto a carrier in the Operations and Checkout (O & C) building. Following integration, the payload is functionally tested and then installed into the orbiter. After the mission, the payload is removed from the orbiter, deintegrated in the O & C building, and the experiments are turned over to the mission manager. One of the many payloads process at KSC consisted of two space construction experiments: the Experimental Assembly of Structures in Extravehicular Activity (EASE) and the Assembly Concept for Construction of Erectable Space Structures (ACCESS). The details of EASE/ACCESS integration, testing, and deintegration are addressed and how this mission can serve as a guide for future space construction payloads is discussed. Author

**N88-10878*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**RESEARCH AND DEVELOPMENT AT THE MARSHALL SPACE FLIGHT CENTER NEUTRAL BUOYANCY SIMULATOR** c14
Vygantas P. Kulpa *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 142-152 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 14B

The Neutral Buoyancy Simulator (NBS), a facility designed to imitate zero-gravity conditions, was used to test the Experimental Assembly of Structures in Extravehicular Activity (EASE) and the Assembly Concept for Construction of Erectable Space Structures (ACCESS). Neutral Buoyancy Simulator applications and operations; early space structure research; development of the EASE/ACCESS experiments; and improvement of NBS simulation are summarized. B.G.

**N88-10879*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**A SYNOPSIS OF THE EVA TRAINING CONDUCTED ON EASE/ACCESS FOR STS-61-B** **c53**
Kathryn A. Havens *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 153-182 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 05I

Experimental Assembly of Structure in EVA (EASE)/Assembly Concept for Construction of Erectable Space Structures (ACCESS) training problems; photography/television coverage; training schedules; flight data file (FDF), and flight rules production are summarized. B.G.

**N88-10880*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**RESULTS OF THE ACCESS EXPERIMENT**
Walter L. Heard, Jr. and Judith J. Watson *In its* Space Construction Oct. 1987 p 183-198 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

All basic EVA space construction tasks included in the experiment were accomplished on-orbit successfully, and the construction task time shows good correlation with neutral buoyancy data. However, the flight assembly times were slightly longer than the best times obtained in the water tank. This result was attributed by the EVA astronauts to the new, tighter tolerance truss hardware used on-orbit as opposed to the well-worn training hardware used in the neutral buoyancy and was, thus, not a space related phenomenon. The baseline experiment demonstrated that erectable structure can be assembled effectively by astronauts in EVA. The success of ACCESS confirmed the feasibility of EVA space assembly of erectable trusses and played a role in the decision to baseline the Space Station as a 5 meter erectable structure. Author

**N88-10881*#** Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.
**EASE (EXPERIMENTAL ASSEMBLY OF STRUCTURES IN EVA) OVERVIEW OF SELECTED RESULTS**
David L. Akin *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 199-227 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

Experimental Assembly of Structures in EVA (EASE) objectives, experimental protocol, neutral buoyancy simulation, task time distribution, assembly task performance, metabolic rate/biomedical readouts are summarized. This presentation is shown in charts, figures, and graphs. B.G.

**N88-10882*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**OVERVIEW OF CREW MEMBER ENERGY EXPENDITURE DURING SHUTTLE FLIGHT 61-B EASE/ACCESS TASK PERFORMANCE**
D. J. Horrigan, J. W. Waligora, J. Stanford, and B. F. Edwards (Technology, Inc., Houston, Tex.) *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 228-235 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The energy expenditure of the Shuttle Flight 61-B crewmembers during the extravehicular performance of Experimental Assembly of Structures in EVA (EASE) and Assembly Concept of Construction of Space Structures (ACCESS) construction system tasks are reported. These data consist of metabolic rate time profiles correlated with specific EASE and ACCESS tasks and crew comments. Average extravehicular activity metabolic rates are computed and compared with those reported from previous Apollo, Shylab, and Shuttle flights. These data reflect total energy expenditure and not that of individual muscle groups such as hand and forearm. When correlated with specific EVA tasks and subtasks, the metabolic profile data is expected to be useful in planning future EVA protocols. For example, after experiencing high work rates and apparent overheating during some Gemini EVAs, it was found useful to carefully monitor work rates in subsequent flights to assess the adequacy of cooling garments and as an aid to preplanning EVA procedures. This presentation is represented by graphs and charts. Author

**N88-10883#** General Accounting Office, Washington, D. C. National Security and International Affairs Div.
**SPACE STATION: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION'S 1987 COST ESTIMATE**
Jul. 1987 20 p
(PB87-220760; NSIAD-87-180FS; B-227537) Avail: NTIS HC A03/MF A01 CSCL 22B

The report examines the coverage and methodology of the National Aeronautics and Space Administration (NASA) space station cost review to explain how NASA had compiled and analyzed the data to support the cost estimate and to identify the categories of included costs. The GAO presented the results of the work in a briefing on 15 April 1987. The fact sheet summarizes and updates the information contained in that briefing. GRA

**N88-10994#** Joint Publications Research Service, Arlington, Va.
**EQUAL-MODULUS VECTOR PROGRAMMED FREQUENCY CONTROL OF MINIMALLY REDUNDANT STRUCTURE OF POWERED, SINGLE-DEGREE-OF-FREEDOM GYROSCOPES FOR SPACECRAFT ATTITUDE CONTROL SYSTEM Abstract Only**
Yu. A. Karpachev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 94 Transl. into ENGLISH from Mekhanika Tverdogo Tela (Moscow, USSR), no. 2, Feb. 1986 p 3-10 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

# 19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

**N88-10884#** National Oceanic and Atmospheric Administration, Washington, D. C. Office of Systems Development
**AN INTRODUCTION TO THE GOES I-M IMAGER AND SOUNDER INSTRUMENTS AND THE GVAR RETRANSMISSION FORMAT**
Raymond J. Komajda (Mitre Corp., Bedford, Mass.) and Keith McKenzie, ed. Oct. 1987 59 p
(NOAA-TR-NESDIS-33) Avail: NTIS HC A04/MF A01

The purpose is to acquaint users with the characteristics of the processed instrument data that will be available from the next series of GOES satellites, GOES I-M. Included are a comparison of the existing VAS instrument with the instruments on the next series of satellites and a definition of the next processed instrument data format. It is the intent to provide direct readout (Mode AAA) users with sufficient background information for preparation for the phaseover from the present GOES satellites to the next generation of GOES. The GOES Variable (GVAR) processed data as it will be retransmitted to direct readout users is presented. Information on the spacecraft, the imaging and sounding instruments, and the ground system is presented only to provide sufficient background and context for an understanding of the GVAR format. The GVAR contains imager and sounder data.
Author

**N88-10995#** Joint Publications Research Service, Arlington, Va.
**CALIBRATION OF ATTITUDE CONTROL SENSORS Abstract Only**
Ye. M. Potapenko *In* ita USSR Report: Engineering and Equipment 4 May 1987 p 95 Transl. into ENGLISH from Mekhanika Tverdogo Tela (Moscow, USSR), no. 2, Feb. 1986 p 11-17 Original language document was announced in IAA as A86-41427 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

# 20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

**N88-10885#** Brookhaven National Lab., Upton, N. Y. Dept. of Nuclear Energy.
**A MATTER-ANTIMATTER PROPULSION SYSTEM FOR MANNED INTERSTELLAR FLIGHT**
James R. Powell and Charles Pelligrino 1987 10 p Presented at the 38th Congress of the International Astronautical Federation, Brighton, United Kingdom, 10 Oct. 1987
(Contract DE-AC02-76CH-00016)
(DE87-013311; BNL-40082; CONF-8710122-1) Avail: NTIS HC A02

The major problems of interstellar flight are addressed in an integrated design of a star ship, Valkyrie. It employs a large diameter (approximately 1 km) thin superconducting current ring to magnetically channel the reaction products from repetitive pellet explosions (either matter-antimatter or fusion) to generate thrust. The thermal intercept fraction on the star ship is very small, approximately 0.000001. Waste heat is radiated to space by a droplet radiator, which also protects against interstellar dust/gas. Maximum velocities in the range 10 to 20 percent of light speed appear possible. DOE

**N88-10886*#** Hughes Aircraft Co., Los Angeles, Calif. Space and Communications Group.
**AUXILIARY PROPULSION SYSTEM FLIGHT PACKAGE Final Report, 16 Jan. 1978 - 31 Dec. 1986**
C. R. Collett Nov. 1987 73 p
(Contract NAS3-21055)
(NASA-CR-180828; NAS 1.26:180828) Avail: NTIS HC A04/MF A01 CSCL 21C

Hughes Aircraft Company developed qualified and integrated flight, a flight test Ion Auxiliary Propulsion System (IAPS), on an Air Force technology satellite. The IAPS Flight Package consists of two identical Thruster Subsystems and a Diagnostic Subsystem. Each thruster subsystem (TSS) is comprised of an 8-cm ion Thruster-Gimbal-Beam Shield Unit (TGBSU); Power Electronics Unit; Digital Controller and Interface Unit (DCIU); and Propellant Tank, Valve and Feed Unit (PTVFU) plus the requisite cables. The Diagnostic Subsystem (DSS) includes four types of sensors for measuring the effect of the ion thrusters on the spacecraft and the surrounding plasma. Flight qualifications of IAPS, prior to installation on the spacecraft, consisted of performance, vibration and thermal-vacuum testing at the unit level, and thermal-vacuum testing at the subsystem level. Mutual compatibility between IAPS and the host spacecraft was demonstrated during a series of performance and environmental tests after the IAPS Flight Package was installed on the spacecraft. After a spacecraft acoustic test, performance of the ion thrusters was reverified by removing the TGBSUs for a thorough performance test at Hughes Research Laboratories (HRL). The TGBSUs were then reinstalled on the spacecraft. The IAPS Flight Package is ready for flight testing when Shuttle flights are resumed. Author

**N88-10832*#** McDonnell-Douglas Astronautics Co., St. Louis, Mo.
**ROCKET NOZZLE THERMAL SHOCK TESTS IN AN ARC HEATER FACILITY**
James H. Painter and Ronald A. Williamson *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 27-41 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 21H

# 23 CHEMISTRY AND MATERIALS (GENERAL)

No abstracts in this category.

# 24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

For ceramic materials see *27 Nonmetallic Materials.*

**N88-10887** Purdue Univ., West Lafayette, Ind.
**EFFECT OF ADHESIVE LAYERS ON IMPACT DAMAGE AND DYNAMIC RESPONSE IN COMPOSITE LAMINATES Ph.D. Thesis**
Said Rechak 1986 187 p
Avail: Univ. Microfilms Order No. DA8710790

Adhesive layers were included along the interfaces of a base line graphite/epoxy (0sub5/90sub5/0sub5) laminate for impact study. Impacted specimens were sectioned longitudinally and transversely for observation of the damage modes. The presence of adhesive layers resulted in the following effects: (1) delamination was effectively suppressed up to very high impact velocities; (2) matrix cracking in the upper lamina was greatly reduced; and (3) the contact area was appreciably increased, thus the stress concentration effect was significantly reduced. One major disadvantage in using adhesive layers was found, i.e., the bending crack in the bottom lamina which could branch out into delamination when adhesive layers were absent tended to penetrate in the middle lamina and break fibers. The use of adhesive strips along the bottom interface would prevent the bending crack from penetrating into adjecent lamina. Calculated crack propagation speed was about 45% the wave speed of graphite/epoxy, in the case of cross ply adhesive, and some 30% the wave speed velocity of graphite/epoxy, for the case of (0sub5/90sub5/0sub5) composite laminates. Dissert. Abstr.

**N88-10888** Drexel Univ., Philadelphia, Pa.
**A STOCHASTIC DELAMINATION GROWTH MODEL FOR FATIGUE LOADED LAMINATED COMPOSITE MATERIALS Ph.D. Thesis**
Ronald Blaise Bucinell 1987 231 p
Avail: Univ. Microfilms Order No. DA8712926

A stochastic model for the growth of delamination in graphite/epoxy laminated composite materials is presented. The model predicts both the mean and variance in the delamination growth behavior. A strain energy release rate based delamination growth power rule is assumed to describe the mean behavior of the delamination growth process. This assumption facilitates the description of the stochastic model parameters in terms of the maximum fatigue load amplitude. This allows the model to predict delamination growth at load levels other than that used to correlate the model. The stochastic model is also used to predict the mean and variance in the growth of delamination when the fatigue load amplitude is allowed to vary. It is shown that the cumulative effects of multiple fatigue load amplitudes are a simple summation of the

constant amplitude effects. An experimental program is conducted to determine the properties of the materials used, estimate the parameters of the model, and verify the predictions of the model. Dissert. Abstr.

**N88-10889#** Oak Ridge Associated Universities, Inc., Tenn.
**ANALYTICAL ELECTRON MICROSCOPY CHARACTERIZATION OF BORON IN SINTERED ALPHA-SiC**
K. L. More, J. Bentley, C. H. Carter, Jr., and R. F. Davis (North Carolina State Univ., Raleigh.) 1987 10 p Presented at the 22nd Annual Meeting of the Microbeam Analysis Society, Kailua-Kona, Hawaii, 13 Jul. 1987 Prepared in cooperation with Oak Ridge National Lab., Tenn.; North Carolina State Univ., Raleigh
(Contracts DE-AC05-84OR-21400; DE-AC05-76OR-00033; Grant NSF DMR-81-20804)
(DE87-012532; CONF-870725-10) Avail: NTIS HC A02/MF A01

The final microstructure of alpha-SiC sintered with the addition of densification aids of elemental carbon and B4C consists of approximately 8 microns alpha-SiC grains, large (greater than 1 micron) B4C grains possibly containing a small amount of silicon, and free carbon (mostly graphite). The sintering of the SiC with a boron-containing phase causes the alpha-SiC grains to become saturated with boron. During annealing experiments and high temperature, constant stress creep experiments, small (10 to 20 nm) B4C precipitates nucleate and grow within the alpha-SiC grains. This precipitate formation was independent of applied stress. No boron was detected on grain boundaries in the starting material or material which had been annealed or deformed. DOE

**N88-10890#** Japan Atomic Energy Research Inst., Tokyo.
**ELECTRON BEAM IRRADIATION EFFECTS ON CARBON FIBER REINFORCED PEEK COMPOSITE**
Tsuneo Sasuga, Miyuki Hagiwara, Tosikazu Odajima, Hideo Sakai, Toshiyuki Nakakura, and Masahiro Masutani Mar. 1987 34 p In JAPANESE; ENGLISH summary
(DE87-753001; JAERI-M-87-048) Avail: NTIS (US Sales Only) HC A03/MF A01

Carbon fiber (CF) reinforced composites, using polyarlether-sulfone (PES) or polyarylether-ether-ketone (PEEK) as matrix material, were prepared and their electron beam irradiation effects were studied on the basis of changes in mechanical and dynamic viscoelastic properties and observation of fracture surfaces. The flexural strength of PES-CF composite decreased to 70% of the initial strength after the irradiation of 3 MGy and 40% after 15 MGy. The change in the profile of stress-strain (S-S) curves and fractographic observation by electron microscopy indicated that this composite irradiated with over 3 MGy was fractured by delamination caused by the degradation of matrix polymer. The mechanical properties of PEEK-CF composite were scarcely decreased even after irradiated up to 180 MGy and this composite showed very high radiation resistance. The change in the profile of S-S curves and fractographic observation showed that this composite fractured due to destruction of fiber in the dose range less than 180 MGy, indicating that PEEK was excellent matrix material used in high radiation field. PEEK-PES-CF composite which was composed of the carbon fibers coated with PES solution showed less radiation resistance compared with PEEK-CF composite; the flexural strength decreased to 85% of the initial value after the irradiation with 90 MGy. It was revealed from the changes in the profile of S-S curve that the specimen irradiated over 120 MGy was fractured due to not only fiber destruction but delamination. Deterioration mechanism of PEEK-PES-CF composite was studied by dynamic viscoelastic measurements in connection with the damage on matrix-fiber interface. It was suggested that the deterioration in mechanical properties of this composite was caused by the degradation of PES that coated on the surface of the carbon fibers. DOE

**N88-10891#** National Aerospace Lab., Tokyo (Japan).
**FRACTURE MODE RESEARCH OF BORON ALUMINUM COMPOSITE MATERIALS BY ACOUSTIC EMISSION (AE)**
Yasushi Sofue and Akinori Ogawa 1987 19 p In JAPANESE; ENGLISH summary
(NAL-TR-927; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

Acoustic Emission (AE) characteristics were investigated for various failure modes (such as fiber breakage, matrix crazing, and delamination) of boron reinforced aluminum composite materials. Tensile tests were conducted on four types of specimens (unidirectional, 0/90 deg ply, boron fiber, and shear lag test pieces). The results show that the AE characteristics (count rate, amplitude distribution, and location) differ with the failure mode. The AE amplitude was above 90 dB for the fiber breakage of the unidirectional ply test piece but below 90 dB for the transverse one of cross ply, which fractured at a low level load, while the shear lag test piece produced an acoustic emission amplitude in the range of 40 to appoximately 60 dB under delamination fracture mode. Author

**N88-10892#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de la Resistance des Structures.
**MODELS OF DEGRADATION OF STRATIFIED COMPOSITE STRUCTURES Final Report [MODELES DE DEGRADATION DE STRUCTURES COMPOSITES STRATIFIEES]**
D. Gilletta and St. Joseph Jan. 1987 57 p In FRENCH
(Contract DRET-86/34-001)
(ONERA-RT-13/3542-RY-061-R; ETN-87-90905) Avail: NTIS HC A04/MF A01

Macroscopic models of the computation of nonlinearities introduced by the degradation of materials in the design of composite structures were developed. Damage variables are introduced in the materials behavior laws, to define the instability conditions characterizing the final rupture. Examples show that the models may accelerate the computation of the instability point of a composite structure. ESA

**N88-10893#** Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.
**CUMULATIVE FATIGUE AND LIFE PREDICTION OF FIBRE COMPOSITES. PART 1: LITERATURE REVIEWS Final Report**
P. M. Barnard and J. B. Young Nov. 1986 122 p
(Contract RAE-11494/2028-0134-XR/MAT)
(BR101013; ETN-87-90922) Avail: NTIS HC A06/MF A01

Factors that contribute to the statistical nature of fiber reinforced plastic materials; fatigue failure mechanisms under tensile, compressive, and shear loading; and life prediction techniques are reviewed. Though the reviews are specifically for unidirectionally reinforced E glass/913 they are expected to be applicable to other laminates. The statistics needed for the life prediction techniques are included. ESA

**N88-10894#** Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.
**CUMULATIVE FATIGUE AND LIFE PREDICTION OF FIBRE COMPOSITES. PART 2: EXPERIMENTAL TECHNIQUES AND RESULTS Final Report**
P. M. Barnard and J. B. Young Jan. 1986 147 p
(Contract RAE-11494/2028-0134-XR/MAT)
(BR101014; ETN-87-90923) Avail: NTIS HC A07/MF A01

Experimental work and test results for unidirectional E-glass/913 under tension and compression loading are presented. The test data is analyzed using the existing life prediction techniques to establish the applicability of these techniques, none of which satisfactorily describe the generated data. A technique based on the strength-life equal rank assumption that appears to provide a powerful life prediction technique is suggested. ESA

**N88-10895#** Oxford Univ. (England). Dept. of Engineering Science.
**AN INVESTIGATION OF THE HIGH STRAIN RATE DEFORMATION OF SiCw/2124 Al COMPOSITE**
J. Harding, M. Taya, B. Derby, and S. Pickard 1987 12 p Presented at the Sixth International Conference on Composite Materials, London, United Kingdom, Jul. 1987 Submitted for-

publication Sponsored in part by the Royal Society, United Kingdom
(OUEL-1675/87; ETN-87-90970) Avail: NTIS HC A03/MF A01

Tensile tests at strain rates from 0.001 to 1500/sec, using a split Hopkinson's pressure bar at the impact rates, were performed on SiCw/2124 Al metal matrix composite specimens with fiber volume fractions of 15 percent and 25 percent. The effect of strain rate on the modulus, flow stress, and elongation to failure is determined. Optical, scanning electron, and transmission electron microscopy are used to examine the deformation and fracture processes. A small strain-rate dependence of the flow stress is observed and a more marked effect on the elongation to failure. ESA

**N88-10896*#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Physics.
**DEGRADATION MECHANISMS OF MATERIALS FOR LARGE SPACE SYSTEMS IN LOW EARTH ORBIT Final Report, 6 Oct. 1982 - 5 Jan. 1985**
William L. Gordon and R. W. Hoffman Nov. 1987 32 p
(Grant NAG3-352)
(NASA-CR-181472; NAS 1.26:181472) Avail: NTIS HC A03/MF A01 CSCL 11D

Degradation was explored of various materials used in aerospace vehicles after severe loss of polymeric material coatings (Kapton) was observed on an early shuttle flight in low Earth orbit. Since atomic oxygen is the major component of the atmosphere at 300 km, and the shuttle's orbital velocity produced relative motion corresponding to approx. 5 eV of oxygen energy, it was natural to attribute much of this degradation to oxygen interaction. This assumption was tested using large volume vacuum systems and ion beam sources, in an exploratory effort to produce atomic oxygen of the appropriate energy, and to observe mass loss from various samples as well as optical radiation. Several investigations were initiated and the results of these investigations are presented in four papers. These papers are summarized. They are entitled: (1) The Space Shuttle Glow; (2) Laboratory Degradation of Kapton in a Low Energy Oxygen Ion Beam; (3) The Energy Dependence and Surface Morphology of Kapton Degradation Under Atomic Oxygen Bombardment; and (4) Surface Analysis of STS 8 Samples. Author

**N88-10897*#** National Aeronautics and Space Administration, Washington, D.C.
**CONTRIBUTION TO THE STUDY OF COMPOSITE MATERIALS AND THEIR DAMAGE Thesis - Paris VI Univ. - 1984**
F. Lene Nov. 1987 355 p Transl. into ENGLISH of Contribution a l'Etude des Materiaux Composites et de Leur Endommagement (France), 1984 p 1-353 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-4005)
(NASA-TT-20107; NAS 1.77:20107) Avail: NTIS HC A16/MF A01 CSCL 11D

Chapter 1 describes the homogenization techniques used for defining the overall behavior of composite materials for conventional cases of linear and perfectly glued elastic constituents. Chapters 2 and 3 focus on solving the problems inherent in two types of degenerated situations: elastic media with microcavities, and elastic media containing rigid inclusions. Through suitable definitions of deformation concepts and macroscopic stresses it is shown that conventional theory results apply naturally to these limits. Author

**N88-10898*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
**A STUDY OF THE MECHANICAL BEHAVIOR OF A 2-D CARBON-CARBON COMPOSITE**
William B. Avery and Carl T. Herakovich Aug. 1987 295 p
(Grant NAG1-343)
(NASA-CR-181476; NAS 1.26:181476; CCMS-87-13; VPI-E-87-15; IR-66) Avail: NTIS HC A13/MF A01 CSCL 11D

The objective of this study was to observe and characterize the out-of-plane fracture of a 2-D carbon-carbon composite and to gain an understanding of the factors influencing the stress distribution in such a laminate. Finite element analysis of a two-ply carbon-carbon composite under in-plane, out-of-plane, and thermal loading were performed. The results indicated that under out-of-plane loading sigma sub x and tau sub xz were strongly dependent on stacking sequence, undulation aspect ratio, and undulation offset ratio, but sigma sub z and sigma sub y were relatively independent of geometry. Under in-plane loading all components of siress were strong functions of geometry. Additionally, large thermal stresses were predicted. Out-of-plane tensile tests revealed that failure was interlaminar, and that cracks propagated along the fiber-matrix interface. An elasticity solution was utilized to analyze an orthotropic fiber in an isotropic matrix under uniform thermal load. The analysis reveals that the stress distributions in a transversely orthotropic fiber are radically different from those predicted assuming the fiber to be transversely isotropic. Author

**N88-10899*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**THE EFFECT OF BROMINATION OF CARBON FIBERS ON THE COEFFICIENT OF THERMAL EXPANSION OF GRAPHITE FIBER-EPOXY COMPOSITES**
D. A. Jaworske and C. Maciag (Cleveland State Univ., Ohio.) Nov. 1987 6 p
(NASA-TM-100236; E-3665-1; NAS 1.15:100236) Avail: NTIS HC A02/MF A01 CSCL 11D

To examine the effect of bromination of carbon fibers on the coefficient of thermal expansion (CTE) of carbon fiber epoxy composites, several pristine and brominated carbon fiber-epoxy composite samples were subjected to thermomechanical analysis. The CTE's of these samples were measured in the uniaxial and transverse directions. The CTE was dominated by the fibers in the uniaxial direction, while it was dominated by the matrix in the transverse directions. Bromination had no effect on the CTE of any of the composites. In addition, the CTE of fiber tow was measured in the absence of a polymer matrix, using an extension probe. The results from this technique were inconclusive. Author

**N88-11001#** Joint Publications Research Service, Arlington, Va.
**NEED FOR COMPOSITES, NEW MATERIALS DISCUSSED**
N. Zhavoronkov, I. Fridlyander, and R. Shalin *In its* USSR Report: Engineering and Equipment 4 May 1987 p 115- 117 Transl. into ENGLISH from Izvestiya (Moscow, USSR), 1 Sep. 1986 p 2 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

# 25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

**N88-10900** George Washington Univ., Washington, D.C.
**NUMERICAL SIMULATION OF A SUPERSONIC CHEMICALLY REACTING MIXING LAYER Ph.D. Thesis**
John Philip Drummond 1987 177 p
Avail: Univ. Microfilms Order No. DA8713000

The physical phenomena present when a supersonic flow undergoes chemical reaction is studied. An understanding of supersonic reacting flows is necessary to successfully develop advanced propulsion systems planned for use later in this century and beyond. To explore such flows, a study was begun to create appropriate physical models for describing supersonic combustion, and to develop accurate and efficient numerical techniques for solving the governing equations resulting from these models. Two computer programs are written to study reacting flows. Both programs are constructed to consider the multicomponent diffusion

and convection of important chemical species, the finite rate reaction of these species, and the resulting interaction of the fluid mechanics and the chemistry. The first program employs a finite difference scheme for integrating the governing equations, whereas the second uses a hybrid Chebyshev pseudospectral technique for improved accuracy. Both programs are used to study a spatially developing and reacting mixing layer, and the results are analyzed to draw conclusions regarding the structure of the evolving layer and its associated flame. Dissert. Abstr.

**N88-10901#** Brookhaven National Lab., Upton, N. Y. Dept. of Applied Science.

**ELECTRONIC CONDUCTION IN MOLTEN SODIUM CHLORIDE**

G. M. Haarberg, K. S. Osen, and J. J. Egan 1987 9 p Presented at the 172d Meeting of the Electrochemical Society, Honolulu, Hawaii, 18-23 Oct. 1987

(Contract DE-AC02-76CH-00016)

(DE87-010063; BNL-39700; CONF-871027-18) Avail: NTIS HC A02/MF A01

The electronic conductivity of molten NaCl was determined as a function of the activity of Na at 850 and 900 C by using the Wagner polarization technique. A new cell design, which prevented evaporation of Na, was essential for obtaining good results. The experimental cell consists of a tantalum crucible containing NaCl in contact with a Na-Bi alloy (15 mol% Na), a reference electrode with a Na-Bi alloy of known composition, and an inert Ta electrode in a sapphire tube of known geometry. The sapphire tube is filled with electrolyte, and the Ta electrode and the sapphire tube form a vacuum tight seal preventing the evaporation of Na. A constant current is applied through the cell, making the Ta cup positive and the Ta electrode inside the sapphire tube negative. The potential between the electrodes is measured as a function of time, and the stationary value obtained after a long time (40 min) is recorded. A series of such corresponding potential versus current data is measured so that the electronic conductivity can be calculated as a function of potential according to the equation Kappa (sub e)= G par. delta I/par. delta E. Electron mobility does not vary much with Na activity. However, evaporation of Na from the crucible occurred during the experiment at 900 C. This caused a change in the composition of the Na-Bi alloy, corresponding to a drop in Na activity. At 850 C, the alloy composition appeared to remain constant during the experiment. DOE

**N88-10902#** Brookhaven National Lab., Upton, N. Y.

**THE ATOMIC WEIGHT AND ISOTOPIC COMPOSITION OF NITROGEN AND THEIR VARIATION IN NATURE**

Norman E. Holden 1987 7 p Presented at the 34th IUPAC General Assembly, Boston, Mass., 21-29 Aug. 1987

(Contract DE-AC02-76CH-00016)

(DE87-012867; BNL-NCS-39949; CONF-8708105-2) Avail: NTIS HC A02/MF A01

Two stable isotopes of nitrogen exist in nature, N-14 and N-15. The less abundant isotope, N-15, was discovered in 1929 by Naude, who studied the band spectra of nitric oxide, NO. However, the main source of a standard for this element is the air in the atmosphere, which is made up of approximately 78% N2. Reviewed in this paper is the measurements of the isotopic composition in air and its variation around the world. Also investigated is the variation of the isotopic composition in the various compounds or sources of nitrogen compared to the value in air. Data on the atomic weight and non-terrestrial data for nitrogen is also reviewed. DOE

**N88-10903#** Lawrence Livermore National Lab., Calif.

**EXPERIMENTAL MOLECULAR SPECTROSCOPY IN SHOCK-COMPRESSED MATERIALS**

D. S. Moore and S. C. Schmidt 1987 10 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20-23 Jul. 1987

(Contract W-7405-eng-36)

(DE87-013139; LA-UR-87-2273; CONF-870753-61) Avail: NTIS HC A02/MF A01

Shocked materials present an exciting challenge to the experimental spectroscopist. The severe constraints in time and space imposed by the shock process can also be accompanied by chemical complexity. Many standard spectroscopic techniques have recently been adapted with varying degrees of success. Those discussed here are UV/visible absorption, emission, and fluorescence, infrared absorption, and spontaneous and coherent Raman scattering. The importance of the connection to both theory and static high-pressure methods is emphasized. DOE

**N88-10904#** Pacific Northwest Labs., Richland, Wash.

**JAPANESE INDUSTRIAL RESEARCH ON LEAN COMBUSTION: A CASE STUDY: INTERNATIONAL RESEARCH MONITORING PROGRAM**

G. J. Hane and R. A. Hutchinson Aug. 1987 55 p

(Contract DE-AC06-76RL-01830)

(DE87-013839; PNL-6210) Avail: NTIS HC A04/MF A01

Japanese automakers have introduced a number of successful lean-combustion engines. These engines make Japanese automobiles the gas mileage leaders of the US market. The lean-combustion engines also provide satisfactory performance and acceptable emissions. U.S. automakers and research managers, who were probably better informed about lean-combustion than the Japanese, actively investigated lean-combustion but did not develop an engine. This report examines the basis for the Japanese innovations, the research that took the Japanese past the US state-of-the-art to permit engine development. A preliminary review of recent (1980s) Japanese literature did not turn up strong evidence of new research activity in the lean-combustion area, but did provide background on new engines developed by several major manufacturers. The study is based solely on Japanese and US published literature, with emphasis on early research conducted in the 1970s. DOE

**N88-10905#** Howard Univ., Washington, D. C. Dept. of Chemistry.

**PHOTOLYTIC PROCESSES FOR MEASUREMENT OF COMBUSTION HEATS OF FORMATION AND REACTION RATES Progress Report**

H. Okabe and J. B. Halpern 1986 9 p

(Contract DE-FG05-85ER-13383)

(DE87-014047; DOE/ER-13383/2) Avail: NTIS HC A02/MF A01

The alkoxy radicals (RO) are important intermediates in combustion of hydrocarbons. Laser-excited fluorescence is being used to detect RO. RO is produced by pulsed 10-Hz photolysis of RONO at 355 nm. The reaction rates of i-C3H7O with NO, O2, CO, CH4, and H2 were measured. The emission bands and lifetime of i-C3H7O were studied. Attempts made to measure the heat of formation of CH3O radicals were not yet successful. DOE

**N88-10906#** Delaware Univ., Newark. Center for Catalytic Science and Technology.

**A SURFACE SCIENCE INVESTIGATION OF POTENTIAL INTERMEDIATES, CATALYSTS, AND PROMOTERS IN THE SYNTHESIS OF HIGHER ALCOHOLS BY METALS Progress Report**

M. A. Barteau 1987 9 p

(Contract DE-FG02-84ER-13290)

(DE87-014188; DOE/ER-13290/3) Avail: NTIS HC A02/MF A01

The goal is to understand the elementary processes involved in the synthesis of methanol and higher alcohols on transition metals and the dependence of these processes on the surface. Results indicate that decomposition of higher alcohols on Pt-group metals proceeds via the reverse of alcohol synthesis pathways. Oxygen atoms adsorbed on Pd(111) play at least 5 roles in altering the selectivity of alcohol conversion on this surface. Although much of the network describing oxygenate chemistry on transition metals is general, the selectivity of these reactions depends strongly on

details of surface-adsorbate and adsorbate-adsorbate interactions. DOE

**N88-10907#** Physical Sciences, Inc., Andover, Mass.
**EXPERIMENTAL AND THEORETICAL STUDY OF CONDENSATION IN MULTICOMPONENT VAPORS Quarterly Report No. 9, 15 Feb. - 14 May 1986**
G. Wilemski Jul. 1987 7 p
(Contract DE-AC02-84ER-13154)
(DE87-013663; DOE/ER-13154/9; PSI-154/TR-691) Avail: NTIS HC A02/MF A01

The program is primarily experimental, but a significant amount of supporting theoretical work is also being performed. The experiments concern the homogeneous nucleation and subsequent growth of mixed clusters formed during the supersonic expansion of gas mixtures containing pairs of mutually condensible species. Theoretical work is concentrating on the calculation of nucleation rates under conditions pertinent to the experiments. A new thermodynamic model for binary cluster composition is being used as a basis for a revised classical theory of binary nucleation rates. Rates calculated with this revised theory, as well as with the standard theory and other existing theories, are being compared with the supersonic expansion data and with data obtained from diffusion cloud chambers and shock tubes to assess adequacy of the various theories. This report covers recent theoretical work on the thermodynamic consistency of binary nucleation theories. DOE

**N88-10908#** Colorado State Univ., Fort Collins. Dept. of Chemical Engineering.
**STUDY OF IMPROVED METHODS FOR PREDICTING CHEMICAL EQUILIBRIA Technical Progress Report, 1 Jul. 1986 - 1 Sep. 1987**
Terry G. Lenz and John D. Vaughan 1987 43 p
(DE-FG02-86ER-13582)
(DE87-014647; DOE/ER-13582/1) Avail: NTIS HC A03/MF A01

We carried out a detailed study of the capabilities and limitations of two force field models (MMP2 and MOLBD3) for calculating thermodynamic properties of -diene and -ene hydrocarbons. New force field parameters were introduced for the MOLBD3 program for unsaturated five-member rings and for methylene-bridged compounds. We investigated the Diels-Alder condensation of 1,3-cyclopentadiene in the temperature range 273 to 500K by use of MOLBD3. Equilibrium constants, standard enthalpies of reaction, and standard entropies of reaction were calculated. The calculated results were compared with experimental data reported in the literature. Anthracene derivatives, maleic anhydride derivatives, and Diels-Alder adducts were synthesized and purified in preparation for future experimental determination of equilibrium constants for various Diels-Alder reactions. The structure of the 9-phenylanthracene-maleic anhydride adduct was determined by X-ray crystallography. Equilibrium constants for the Diels-Alder reaction of 9-phenylanthracene and maleic anhydride in 1,2,4-trichlorobenzene were determined for seven temperatures between 124 and 175 C. DOE

**N88-10909#** California Univ., Berkeley. Lawrence Berkeley Lab.
**THE EFFECT OF ADDITIVES ON THE REACTIVITY OF PALLADIUM SURFACES FOR THE CHEMISORPTION AND HYDROGENATION OF CARBON MONOXIDE: A SURFACE SCIENCE AND CATALYTIC STUDY Ph.D. Thesis**
Thomas George Rucker Jun. 1987 195 p
(Contract DE-AC03-76SF-00098)
(DE87-014685; LBL-23804) Avail: NTIS HC A09/MF A01

The role of surface additives on the catalytic activity and chemisorptive properties of Pd single crystals and foils is studied. Effects of Na, K, Si, P, S, and Cl on the bonding of CO and H and on the cyclotrimerization of acetylene on the (111), (100) and (110) faces of Pd were investigated in addition to role of TiO2 and SiO2 overlayers deposited on Pd foils in the CO hydrogenation reaction. On Pd, only in the presence of oxide overlayers, are methane or methanol formed from CO and H2. The maximum rate of methane formation is attained on Pd foil where 30% of the surface is covered with titania. Methanol formation can be achieved only if the TiO(sub x)/Pd surface is pretreated in 50 psi of oxygen at 550 C prior to the reaction. The additives (Na, K, Si, P, S, Cl) affect the bonding of CO and hydrogen and the cyclotrimerization of acetylene to benzene by structural and electronic interactions. In general, the electron donating additives increase the desorption temperature of CO and increase the rate of acetylene cyclotrimerization and the electron withdrawing additives decrease the desorption temperature of CO and decrease the rate of benzene formation from acetylene. decrease the desorption temperature of CO and decrease the rate of benzene formation from acetylene. DOE

**N88-10910#** Japan Atomic Energy Research Inst., Tokyo.
**STUDIES ON SURFACE CHEMICAL STATES OF SOME METALS AND CERAMICS BOMBARDED WITH ENERGETIC LIGHT-IONS**
Yuji Baba Feb. 1987 87 p
(DE87-752975; JAERI-1304) Avail: NTIS (US Sales Only) HC A05/MF A01

An electron spectroscopy was applied to the investigation of surface chemical state of some metals and ceramics bombarded with energetic light ions. Bombardments of keV-order hydrogen ions on Sc, Ti, V, Y, Zr and Nb induced the XPS core-line chemical shifts to higher binding-energies by 0.2 to 1.4 eV, the appearance of new photopeaks at 3.0 to 5.0 eV below the Fermi level. Although the peak energies are lower by 1 to 3 eV than those calculated for MeH sub 2 (Me = metal) by molecular-orbital theory, the peaks are assigned to the metal-H bonds. The chemical shifts induced by bombarding hydrogen-ions were also observed in the X-ray-induced Auger electron spectra (XAES) For Y, Zr and Nb. The hydride layers produced by the ion-implantation are more stable at high temperature than those obtained by thermal synthesis, because of the surface damages which prevent thermal diffusion of hydrogen. In the case of hydrogen-ion bombarded SiC, carbon enriched layer was observed in the near surface region, while the surfaces of Si sub 3 N sub 4 and SiO sub 2 became silicon-rich after the bombardments. On the other hand, the bombardments of H/sub 2//sup +/, D/sub 2//sup +/ and He/sup +/-ions on TiC, TiN and TiO/sub 2/ made their surfaces titanium-rich. At high fluences, the X/Ti (X = C, N, O) become constant. The energy dependences of the steady state values of the C/Ti ratios have maximum at 2 to 4 keV/atom of incident ion, while those of the N/Ti and O/Ti ratios decreased with the increase in the ion energies. Incident-energy dependences of the Ti/sup +//X/sup +/ ratios determined by SIMS substantiate that the sputtering is responsible for the surface compositional change of the binary compounds. The surface of TiO/sub 2/ was easily reduced to Ti/sub 2/O/sub 3/ by the H/sub 2//sup +/ and D/sub 2//sup +/, or to TiO by the He/sup +/ and Ar/sup +/-ion bombardments. DOE

**N88-10911#** Laboratoire Central des Ponts et Chaussees, Paris (France). Div. Materiaux de Chaussees.
**APPLICATION OF HIGH PERFORMANCE LIQUID CHROMATOGRAPHY TO THE FAST DETERMINATION OF BITUMEN GENERIC COMPOSITON [APPLICATION DE LA CHROMATOGRAPHIE LIQUIDE A HAUTE PERFORMANCES (CLHP) A LA DETERMINATION RAPIDE DE LA COMPOSITION GENERIQUE DES BITUMES]**
Bernard Brule and Monique Zumer Feb. 1984 102 p In FRENCH
(PC-2; ISBN-2-7208-3513-7; ISSN-0755-2351; ETN-87-90645)
Copyright Avail: NTIS HC A06/MF A01

Bitumen composition is characterized by the identification and quantization of generic groups including saturated and aromatic oils, resins, and asphaltenes. A back-flush technique is employed. The operating parameters are explored to optimize the speed and reproducibility of the method. The application to the fast determination of the colloid instability limit is also discussed. ESA

**N88-10912#** Laboratoire Central des Ponts et Chaussees, Paris (France). Service de Chimie.
**COLLOIDAL STRUCTURE OF BITUMENS. RELATIONSHIP BETWEEN COMPOSITION-STRUCTURE BEHAVIOR [STRUCTURE COLLOIDALE DES BITUMES. RELATIONS ENTRE COMPOSITION STRUCTURE-COMPORTEMENT]**
Yvonnick Brion Jun. 1984 54 p In FRENCH
(PC-4; ISBN-2-7208-3519-6; ISSN-0755-2351; ETN-87-90646)
Copyright Avail: NTIS HC A04/MF A01

Bitumen manufacturing procedures, chemical composition, and characterization are reviewed. Several structural states can be defined, corresponding to different rheological behaviors. The factors having an influence on bitumen colloidal stability are also studied, including electrolytic dissociation and the chemical composition of the dispersing media. Artificial aging methods highlight the changes of rheological behavior. ESA

**N88-10913#** Kernforschungszentrum, Karlsruhe (West Germany). Inst. Fuer Radiochemie.
**AUGER ELECTRON SPECTROSCOPY OF OXIDIZED TITANIUM OVERLAYERS: SPECIATION OF HOMOGENEOUS AND HETEROGENEOUS SAMPLES**
H. Moers, H. Klewe-Nebenius, and G. Pfennig May 1987 24 p
(KfK-4221; ISSN-0303-4003; ETN-87-91031) Copyright Avail: NTIS HC A02/MF A01

Auger electron spectroscopy (AES) quantitative analysis of titanium oxides and its application to the characterization of a partially oxidized titanium overlayer on top of a copper substrate are discussed. The quantification procedure described provides an average composition of the surface area investigated. Care has to be taken to convert this composition into information about the chemical species present at the sample surface because the observed fine structures of the AES spectra cannot be correlated unambiguously with the chemical species present. The AES spectra are not suited to distinguish conclusively between homogeneous composition of the analyzed volume and the presence of a mixture of several titanium species. Additional information is required for a final distinction between the two possibilities, which can be achieved, for example, by X-ray photoelectron spectroscopy. ESA

**N88-10847*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**HIGH INTENSITY 5 eV O-ATOM EXPOSURE FACILITY FOR MATERIAL DEGRADATION STUDIES**
J. B. Cross, L. H. Spangler, M. A. Hoffbauer, F. A. Archuleta, Lubert Leger, James Visentine, and Don E. Hunton (Air Force Geophysics Lab., Hanscom AFB, Mass.) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 209-226 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 07D

# 26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

**N88-10914#** Eckart-Werke, Fuerth (West Germany).
**DEVELOPMENT OF A PILOT PLANT FOR THE PRODUCTION OF RAPIDLY SOLIDIFIED ALUMINUM ALLOY POWDERS Final Report, Nov. 1985**
Rainer Gerstner, Hans-Claus Neubing, and Georg Reif Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 107 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn, West Germany
(BMFT-FB-T-86-153; ISSN-0340-7608; ETN-87-90562) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, Fed. Republic of Germany DM 22

A production plant for powder metallurgical aluminum alloys was developed in order to improve materials characteristics. The fundamentals of the atomizing technique, and the atomizing arrangement are explained. Different atomizing jets and diverse gases can be used. The test results demonstrate that the plan fullfils all the requirements for the planned material developments. ESA

**N88-10915#** Sandia National Labs., Albuquerque, N. Mex.
**MICROSTRUCTURAL EVOLUTION AND RESPONSE TO DOUBLE-LOOP REACTIVATION TESTING OF HEAT-TREATED pH 13-8 Mo MARTENSITIC STAINLESS STEEL**
Wendy R. Cieslak, Michael J. Cieslak, and Charles R. Hills 1987 4 p Presented at the 172d Meeting of the Electrochemical Society, Honolulu, Hawaii, 18 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-009058; SAND-87-1030C; CONF-871027-9) Avail: NTIS HC A02/MF A01

The double loop electrochemical potentiokinetic reactivation (DL-EPR) test was used to investigate the intergranular and interlath corrosion susceptibility of pH 13-8 Mo as a function of heat treatment. Degree of sensitization was measured to the ratio of the peak current on a reverse (reactivation) scan to that on the forward anodic scan. Corrosion morphology was characterized by SEM, and microstructure by AEM. PH 13-8 Mo in the as-received condition was not sensitized. Precipitation-strengthening to the H925 temper caused susceptibility to intergranular corrosion, and averaging at H1150 caused susceptibility to interlath corrosion. Corrosion susceptibility was most likely caused by a classic Cr-depletion mechanism. DOE

**N88-10916#** Sandia National Labs., Albuquerque, N. Mex. Shock Wave and Explosive Physics Div.
**STATIC MAGNETIZATION AND MICROWAVE LOSS IN SHOCK-MODIFIED FERRITES**
E. L. Venturini, R. A. Graham, and B. Morosin 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contracts DE-AC04-76DP-00789; N00014-86-F-0091)
(DE87-012362; SAND-87-0315C; CONF-870753-22) Avail: NTIS HC A02/MF A01

High-pressure shock loading of cubic nickel ferrite and hexagonal barium ferrite powders results in substantial residual strain, producing changes in the magnetic anisotropy through magnetostrictive coupling. Both the static magnetization and the absorption of microwaves are strongly altered in nickel ferrite, with somewhat smaller changes in barium ferrite. DOE

**N88-10917#** Lawrence Livermore National Lab., Calif.
**RAREFACTION VELOCITIES IN SHOCKED LEAD**
D. A. Boness, J. M. Brown (Washington Univ., Seattle.), and J. W. Shaner 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20-23 Jul. 1987
(Contract W-7405-eng-36)
(DE87-013141; LA-UR-87-2283; CONF-870753-59) Avail: NTIS HC A02

By use of the optical analyzer technique, the bulk sound velocity in shocked lead has been measured at nine points along its Hugoniot in the pressure range 54.5 to 380 GPa. The lowest-pressure points exhibit no sign of solid behavior. The bulk sound velocity is essentially linear with respect to density, and the Gruneisen parameter, gamma, fails to follow a constant rho-gamma model. Results are consistent with zero-pressure values. DOE

**N88-10918#** Los Alamos National Lab., N. Mex. Center for Materials Science.
**FORMATION OF AMORPHOUS ALLOYS BY SOLID STATE REACTIONS**
Ricardo B. Schwarz 1987 27 p Presented at the 6th International Conference on Rapidly Quenched Metals, Montreal, Quebec, 3-8 Aug. 1987 Submitted for publication
(Contract W-7405-eng-36)

(DE87-013175; LA-UR-87-2571; CONF-870893-3) Avail: NTIS HC A03/MF A01

Amorphous metallic alloys have been traditionally prepared by the rapid solidification of molten alloys. New methods of synthesis have been recently developed which are based on isothermal solid state reactions between pure metals. These are carried out at temperatures that kinetically favor the interdiffusion of the species but precludes the nucleation of intermetallics. Other novel methods of synthesis rely on the mechanical attrition of crystalline alloy powders. The paper reviews the basic concepts behind the novel methods of synthesis and compares the amorphous alloys prepared by these techniques with those obtained by the rapid solidification of melts. DOE

**N88-10919#** Science Research Corp., Somerville, Mass.
**STUDIES ON TEMPORAL FIELD EMISSION FROM STAINLESS STEEL SURFACES Final Report, 30 Apr. - 30 Jun. 1987**
30 Jun. 1987 35 p Prepared in cooperation with LLNL, Calif.
(Contract W-7405-eng-48)
(DE87-014237; UCRL-15929; SRL-03-F-1987) Avail: NTIS HC A03/MF A01

The Free Electron Laser imposes stringent requirements on the emittance of the drive electron beam. However, constraints on the injector and accelerator sections of the FEL are imposed by maximum allowable electric field stresses which limit the ability to produce low emittance beams. Research presented in this report is an effort to measure the time dependent field emission of electron current from a variety of prepared stainless steel surfaces. Results indicate that the threshold electric field for emission ranged from 75 kV/cm for stainless steel machined to an RMS surface roughness of .000125" to 280 kV/cm for GREENED stainless steel. The effect on the field emission threshold due to the presence of a barium oxide evaporation source was also investigated. These experiments more closely represent the conditions present in the injector of an FEL which utilizes a thermionic emitter cathode. A reduction in the emission threshold (230 kV/cm) for the GREENED stainless steel surface was observed. DOE

**N88-10920#** International Centre for Theoretical Physics, Trieste (Italy).
**ON THE INTERACTION OF A PLANAR METAL SURFACE WITH A CHARGE AND WITH A MOLECULE**
G. Mukhopadhyay Nov. 1986 51 p
(DE87-703083; IC-86/359) Avail: NTIS (US Sales Only) HC A04/MF A01

We present a dynamic response approach to the interaction of a planar metal surface described by the semi-infinite jellium with a charge and with a molecule. In particular, we express the dynamic image potential of a moving charge as well as the van der Waals interaction energy of a neutral atom or molecule (static as well as moving) in terms of a form factor F(k, omega). This form factor F is not known accurately for general k and omega, and we discuss various formulas for different approximate forms for F. We show that the weakening (or saturation) of the interactions at distances close to the surface is determined mainly by the large k behavior of F and therefore we emphasize the need for an accurate numerical determination of this form factor for large k-regime. DOE

**N88-10921#** Oak Ridge National Lab., Tenn.
**STRUCTURE OF RAPIDLY SOLIDIFIED Ni-Ti**
E. A. Kenik, M. J. Godbole, D. H. Lowndes, A. J. Pedraza (Tennessee Univ., Knoxville.), and D. F. Pedraza 1987 10 p Presented at the 22nd Annual Meeting of the Microbeam Analysis Society, Kailua-Kona, Hawaii, 13 Jul. 1987 Prepared in cooperation with Tennessee Univ., Knoxville
(Contract DE-AC05-84OR-21400)
(DE87-012252; CONF-870725-11) Avail: NTIS HC A02/MF A01

Rapid solidification of NiTi under splat-quenching (SQ) and laser-melting (LM) produces several structural modifications. The SQ material exhibits a marked (200) texture with columnar growth. LM produces epitaxial regrowth with a similar grain size. XRD indicates the presence of B2 and martensite in the SQ material. In general, TEM indicates similar results. Martensite formation is suppressed in the near-surface region, presumably as a result of high cooling rates. The R phase observed by AEM may be incommensurate, only present in small amounts, or present only near the midplane of the SQ material. As such, additional XRD and TEM studies are planned to address these points. The near-surface region of the SQ material also exhibits Ti-rich (TiX) precipitates, and Cu2O cubes. The dominant phase indicated by XRD in the LM material is a LI0 structure with a slight monoclinic distortion. A significant reduction in the amount of martensite in the LM zone relative to the SQ material is indicated by both XRD and TEM. On the basis of TEM, the near-surface region of the LM material exhibits only a B2 (possibly LI0) matrix and a thin surface layer of TiC, which depletes the adjacent B2 of titanium. No amorphization or decrease in order of the B2 phase was observed after rapid solidification. DOE

**N88-10922#** Los Alamos National Lab., N. Mex.
**ELASTIC MODULI OF COPPER UNDER COMPRESSION**
G. K. Straub, J. M. Wills, and D. C. Wallace 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract W-7405-eng-36)
(DE87-013137; LA-UR-87-2260; CONF-870753-62) Avail: NTIS HC A02/MF A01

Starting with a description of the electronic structure of copper, we have studied the zero temperature elastic moduli to 1 Mbar. We have used an empty-core model pseudopotential for the conduction electrons, treated the d-electron interactions in tight binding theory, and calculated the elastic moduli and their volume and pressure derivatives. The results are compared with experiment and with Full Potential Linear Muffin-Tin Orbital (FPLMTO) bandstructure calculations for the elastic moduli and their pressure derivatives. DOE

**N88-10923#** Lawrence Livermore National Lab., Calif.
**TENSILE BEHAVIOR OF SUPERPLASTIC Al-Cu-Li-Zr ALLOY 2090 AT CRYOGENIC TEMPERATURES**
J. Glazer, J. W. Morris, Jr., and T. G. Nieh (Lockheed Missiles and Space Co., Palo Alto, Calif.) Jan. 1987 14 p Presented at the International Cryogenic Materials Conference, St. Charles, Ill., 10 Jan. 1987 Prepared in cooperation with Lockheed Missiles and Space Co., Palo Alto, Calif.
(Contract DE-AC03-76SF-00098)
(DE87-014084; LBL-22817; CONF-870187-1) Avail: NTIS HC A03/MF A01

The tensile behavior of superplastic Al-Cu-Li-Zr alloy 2090 sheet at cryogenic temperatures is investigated in both superplastically formed and unformed material. In both cases, the tensile properties improve significantly at low temperatures. The improvement in uniform elongation between room temperature and 4°K is especially large. As in other 2090 material with different microstructures, this improvement seems to be associated with increased strain hardening rates at low temperatures. A transition in tensile failure model with decreasing temperature is also observed. DOE

**N88-10924#** Sandia National Labs., Albuquerque, N. Mex.
**FIELD ION MICROSCOPE STUDIES OF SURFACE RECONSTRUCTIONS**
G. L. Kellogg 1987 6 p Presented at the 34th International Field Emission Symposium, Osaka, Japan, 13 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-014644; SAND-87-1206C; CONF-870780-2) Avail: NTIS HC A02/MF A01

The reconstruction of various metal surfaces has been investigated in atomic detail with the field ion microscope. Unreconstructed (bulk-terminated) surfaces were produced by low-temperature field evaporation and induced to reconstruct either by heating alone or heating in the presence of deuterium. Field ion microscope images recorded before and after the field-free heating interval were used to determine the temperature at which

restructuring takes place and the structure of the reconstructed surface. The results clearly showed that the (110) planes of Pt and Ir reconstruct to missing-row structures. The temperature required for restructuring was approximately 300°K for Pt and 500°K for Ir. The reconstructions were observed for (110) planes as large as 40 to 50 A diameter and for clusters as small as five atoms. The direct observation of missing-row structures for these small clusters provides convincing evidence that the reconstructions are driven by short-ranged atomic interactions. Missing-row structures were also produced on higher index planes of Pt such as (311), (211), and (511) by heating to temperatures above 400 K. DOE

**N88-10925#** California Univ., Berkeley. Lawrence Berkeley Lab.
**THE CORROSION OF IRON ROTATING HEMISPHERES IN 1 M SULFURIC ACID: AN ELECTROCHEMICAL IMPEDANCE STUDY Ph.D. Thesis**
Chrystalla C. Haili Jun. 1987 360 p
(Contract DE-AC03-76SF-00098)
(DE87-014679; LBL-23776) Avail: NTIS HC A16/MF A01

The corrosion of iron in sulfuric acid is investigated and analyzed. Objectives were: to elucidate the complex behavior of the iron-sulfuric acid system, particularly the reaction mechanism, the passivation process, and the observed limiting current and electrochemical oscillations; to improve fundamental understanding of metal corrosion and passivation phenomena; and to demonstrate the use of the electrochemical impedance method as a tool for the study of electrochemical systems. Experiments carried out were: (1) potentiodynamic analysis to determine the anodic polarization curve, especially the passivation curve; (2) potentiostatic experiments recording the sustained current oscillations that occur within a certain potential range on the limiting current plateau; (3) measurement of the ac impedance of the system at several points along the anodic polarization curve, using a frequency response analyzer. Rotating hemispherical iron electrodes were used. The Kramers-Kronig relations were applied to the electrochemical impedance. Experimental results were compared with theoretical to elucidate the behavior of the iron-sulfuric acid system. A concentrated-solution model was used to calculate the impedance, in addition to analytic calculations using infinitely-dilute-solution theory. Calculated results for the reaction mechanism did not agree with experimental results. DOE

**N88-10926#** Japan Atomic Energy Research Inst., Tokyo.
**COOPERATIVE ANALYSIS OF ZIRCONIUM AND ZIRCONIUM ALLOYS BY FLUORESCENT X-RAY METHOD**
Kyoichiro Takashima, ed. Mar. 1987 137 p In JAPANESE; ENGLISH summary
(DE87-753011; JAERI-M-86-198) Avail: NTIS (US Sales Only) HC A07/MF A01

The Second Sub-Committee on Zircaloy Analysis was organized in April, 1978, under the Committee on Analytical Chemistry of Nuclear Fuels and Reactor Materials, JAERI, for the renewal of zirconium and zirconium alloys certified reference materials (CRM's). The Sub-Committee has decided certified values of major constituents (4 elements) and impurities (14 elements) of the renewed CRM's in July, 1983, based on the result obtained by cooperative analyses, during 1978 to 1983. The CRM's are issued by JAERI. In this report, outline on 1st to 9th cooperative analyses by fluorescent X-ray method is described. In these cooperative works, decision of provisional certified values for alloying elements in JAERI-Z11 to -Z14, harmonization of the certified values with that of JAERI-Z1 to -Z3 and NBS SRM 1213 to 1215, homogeneity test of impurity elements and developments of new analytical method for hafnium were carried out with nine participating laboratories. DOE

**N88-10927#** British Library Lending Div., Boston Spa (England).
**THE WATER PERMEABILITY OF MULTI-LAYER COATINGS**
V. Sh. Pavlyutenkova, A. I. Semavina, G. P. Koroleva, V. V. Pokidyshev, and T. K. Sergeeva [1987] 5 p Transl. into ENGLISH from Stal' (USSR), no. 12, 1986 p 88-89
(BLL-M-37252-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

Water permeability is considered for two multilayer coatings consisting of alternate layers of nickel and copper on steel wire rod. Bent specimens were tested at room temperature in a corrosive medium. A thicker coating was found to be the least permeable to hydrogen. When tested under load in a special autoclave, specimens with both thick and thin coatings did not fail up to 1200 hrs. When the coated wires have been tested under dynamic loads it should be possible to recommend their production. Author

**N88-10928#** British Library Lending Div., Boston Spa (England).
**HARDENING OF METAL DURING PRODUCTION OF BENT SHAPES**
S. Ya. Seredenko and V. V. Klepanda [1987] 10 p Transl. into ENGLISH from Stal' (USSR), no. 12, 1986 p 66-69
(BLL-M-37250-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

The theoretical and experimental research confirms that the strength properties of a bent rolled product shape depend on the properties of the starting metal, the shaping conditions and the type and dimensions of the shape. They are higher the stronger the starting metal, the lower the relative radii of the fillets and the greater the fold angles as well as the greater the specific proportion of the work hardened parts in the total cross section of the shape. The increases in tensile strength and yield strength of the shape as compared with the starting metal lie between 2 and 10 to 12 percent and between 3 and 17 to 24 percent respectively depending on the proportion of work hardened metal in the total cross section. It is recommended on the strength of the mutual closeness of their theoretical and experimental results that these increments should be included in the strength and rigidity calculations of the structures of machines, mechanisms and equipment employing these shapes to determine the possibility of using thinner shapes and thus providing considerable metal economy within the national economy. Author

**N88-10929#** United Kingdom Atomic Energy Authority, Risley (England).
**THERMAL RESISTANCE OF CONTACTING METAL SURFACES AT HELIUM TEMPERATURES**
N. V. Zavaritskii 9 Sep. 1987 5 p Transl. into ENGLISH from Zhurnal Tekhnicheskoi Fiziki (USSR), v. 21, no. 4, 1951 p 453-457
(BLL-Risley-Tr-5500-(9091.9F)) Avail: British Library Lending Div., Boston Spa, United Kingdom

In solving a number of physical problems it is often necessary to make thermal contact of the body under investigation with the surrounding medium followed by the thermal insulation of the body. To achieve this, the object being investigated is normally fixed or suspended from poor thermal conductors inside a chamber, surrounded by the cooling medium. Thermal contact with this medium is achieved by the thermal conductivity of the gas which fills the chamber. Since the thermal contact and subsequent thermal insulation had to be instantaneous, the gas contact was replaced with direct mechanical contact. The results of the measurements are discussed. B.G.

**N88-10930#** British Library Lending Div., Boston Spa (England).
**INVESTIGATION OF THE STRUCTURE OF COATINGS OF SELF FLUXING ALLOYS FUSED BY LASER ENERGY**
V. M. Vlasov, V. T. Seroshtan, S. A. Makarova, P. V. Kochetkov, and G. V. Drozdova 1987 11 p Transl. into ENGLISH from Stal' (USSR), no. 1, 1987 p 88-91
(BLL-M-37301-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

A study was made of the laser fusion of coatings of self fluxing alloys applied to components to increase their surface hardness during use. The microstructure and phase composition of the coatings were investigated on optical and electron microscopes and a diffractometer. Electron probe X-ray analysis was used to determine the distribution of elements in the coatings. Data

obtained indicate that the optimum structure of coatings for particular service conditions can be obtained by varying the parameters of the laser fusion. Author

**N88-10931#** British Library Lending Div., Boston Spa (England).
**A GEOMETRICAL MODEL FOR DETERMINING THE PHYSICOCHEMICAL PROPERTIES OF TERNARY METALLIC SYSTEMS**
M. I. Gasik, E. O. Ostreiko, A. O. Ivankov, A. N. Morozov, and I. V. Andrianov 1987 7 p Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy Chernaya Metallurgiya (USSR), no. 1, 1987 p 4-6
(BLL-M-37303-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

A geometrical model and a procedure is described for determining the physical and chemical properties of ternary metallic systems from data for boundary binary systems. The model and method can be used for finding optimum alloy compositions and improving technological processes. Author

**N88-10932#** British Library Lending Div., Boston Spa (England).
**ANALYSIS OF PHASE EQUILIBRIA IN NITI-C SYSTEM IN HIGH NICKEL REGIONS**
T. A. Dudorova, Yu. G. Gurevich, and N. R. Frage 1987 9 p Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy Chernaya Metallurgiya (USSR), no. 1, 1987 p 6-10
(BLL-M-37304-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

A thermodynamic analysis was made of high nickel regions in the Ni-Ti-C system at temperatures of 1873 to 2073 K. To determine the region of stability of phases, two phase graphite-melt and melt-TiC sub x equilibria were examined, as well as three phase graphite-melt-TiC sub x equilibria. The equilibrium parameters of the Fe-Ti-C and Ni-Ti-C systems were established. Author

**N88-10933#** British Library Lending Div., Boston Spa (England).
**INFLUENCE OF THERMOCYCLIC TREATMENT ON MOBILITY OF GRAIN BOUNDARIES**
A. A. Baranov, V. I. Alimov, and V. G. Onoprienko 1987 4 p Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy Chernaya Metallurgiya (USSR), no. 1, 1987 p 153-154
(BLL-M-37329-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

Thermocyclic heating being an effective method of grain refining, graphs of the number of preheating cycles against size of the austenitic grains in 50mm diameter, 65 grade steel wire are plotted experimentally for subsequent heating to 850, 950, and 1050 C. The effectiveness of the preliminary heating increases substantially with increase in heating temperature to 1050 C; the greater the number of preheating cycles the greater is the thermal stability of the resultant austenitic grain. A description is given of the mechanism underlying this effect. Author

**N88-10934#** British Library Lending Div., Boston Spa (England).
**THERMODYNAMICS OF INTERACTION BETWEEN NITROGEN AND MOLTEN NICKEL ALLOYS**
A. A. Klachkov, S. A. Glazov, V. V. Yurin, G. I. Kotelnikov, and A. Ya. Stomakhin 1987 9 p Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy Chernaya Metallurgiya (USSR), no. 1, 1987 p 49-52
(BLL-M-37309-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

The article describes how a particular nickel-base alloy was subjected to calorimetry at a high temperature with the nitrogen pressure in the chamber varying widely. The results of the experiments and the theory of quasi-regular solutions were used for calculating the solubility of nitrogen in the alloy and the formation of nitrides in it with the experiment parameters varied over extended ranges. The calculation procedure and the data obtained can also be used for calculating the conditions under which nitrides form in alloys with compositions close to that investigated, with appropriate adjustments made to the coefficients in the equations. Author

**N88-10935#** British Library Lending Div., Boston Spa (England).
**RELATIONSHIPS GOVERNING CHANGE IN DENSITY IN LIQUID FERROUS ALLOYS**
M. R. Filonov, S. V. Ushakov, and E. S. Filippov 1987 9 p Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy Chernaya Metallurgiya (USSR), no. 1, 1987 p 10-13
(BLL-M-37305-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

A study was made of the behavior of the density of liquid alloys of binary systems of iron with nickel, tin, silicon, tungsten, and niobium with low percentages of the second element. The method of continuous alloying of a sessile drop was used in measuring density. Experimental and calculated indices of the structure of the various melts were analyzed. The non-monotonic nature of change in the density of the Fe-base alloys was established. Models of spheres of interaction of atoms in weak solutions were used to explain the sudden change in density with certain alloying element concentrations. Author

**N88-10936#** Institut National des Sciences Appliquees de Lyon, Villeurbanne (France).
**STUDY OF THE MICROSCOPIC MECHANISMS OF CYCLIC DEFORMATION. DEVELOPMENT OF A NEW APPROACH: THE CASE OF ALUMINUM Ph.D. Thesis [ETUDE DES MECANISMES MICROSCOPIQUES DE LA DEFORMATION CYCLIQUE. DEVELOPPEMENT D'UNE NOUVELLE APPROCHE. CAS DE L'ALUMINIUM]**
Jean Chicois 1987 184 p In FRENCH
(ISAL-87-0003; ETN-87-90896) Avail: NTIS HC A09/MF A01

The microstructural behavior of 5N aluminum was studied using cyclic deformation fatigue tests. The results are modeled in terms of dislocation and crystal defects. A purely elastic fatigue machine was built in order to provide the necessary precision to measurements covering 0.000001 to 0.01 strains and temperatures from minus 200 to 200 C. It is shown that at low amplitude the interaction dislocations/solid solution atoms control the deformation while at larger amplitudes the interaction dislocations/dislocations become preponderant. ESA

**N88-10937** Oxford Univ. (England). Dept. of Engineering Science.
**STRAIN RATE EFFECTS IN FAST-GAS-COOLED URANIUM-TITANIUM AND URANIUM-NIOBIUM ALLOYS**
S. J. Shaibani, J. Harding, K. Dunn, and G. I. Turner (Atomic Weapons Research Establishment, Aldermaston, England ) 1987 11 p Presented at IMPACT 87, Bremen, Fed. Republic of Germany, May 1987 Submitted for publication Sponsored by the United Kingdom Ministry of Defense Procurement Executive
(OUEL-1683/87; ETN-87-90972) Copyright Avail: Issuing Activity

For fast-gas-cooled alloys of uranium with 3/4% titanium, and 2 1/4 percent niobium, tensile stress-strain curves were obtained at strain rates nominally 0.01, 2 and 1000/sec. At any given strain rate there is little effect of aging treatment on the flow stress of either alloy. The alloys, however, show a marked strain-rate sensitivity, both of the flow stress and the fracture elongation. They differ in that for the uranium 3/4 percent titanium alloy the fracture elongation decreases with increasing strain rate and is independent of aging treatment, whereas for the uranium 2 1/4 percent niobium alloy the fracture elongation increases with increasing strain rate but decreases after treating at the highest aging temperature. ESA

**N88-10938*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**HIGH TEMPERATURE METAL MATRIX COMPOSITES FOR FUTURE AEROSPACE SYSTEMS**
Joseph R. Stephens Oct. 1987 18 p Presented at the ASM International Composite Session, Cincinnati, Ohio, 13-15 Oct. 1987
(NASA-TM-100212; E-3821; NAS 1.15:100212) Avail: NTIS HC A03/MF A01 CSCL 11F

Research was conducted on metal matrix composites and intermetallic matrix composites to understand their behavior under anticipated future operating conditions envisioned for aerospace power and propulsion systems of the 21st century. Extremes in environmental conditions, high temperature, long operating lives, and cyclic conditions dictate that the test evaluations not only include laboratory testing, but simulated flight conditions. The various processing techniques employed to fabricate composites are discussed along with the basic research underway to understand the behavior of high temperature composites, and the relationship of this research to future aerospace systems.

Author

**N88-10939*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**A MICROSTRUCTURAL LATTICE MODEL FOR STRAIN ORIENTED PROBLEMS: A COMBINED MONTE CARLO FINITE ELEMENT TECHNIQUE**

J. Gayda and D. J. Srolovitz Nov. 1987 32 p

(NASA-TM-100215; E-3824; NAS 1.15:100215) Avail: NTIS HC A03/MF A01 CSCL 11F

A specialized, microstructural lattice model, termed MCFET for combined Monte Carlo Finite Element Technique, was developed which simulates microstructural evolution in material systems where modulated phases occur and the directionality of the modulation is influenced by internal and external stresses. In this approach, the microstructure is discretized onto a fine lattice. Each element in the lattice is labelled in accordance with its microstructural identity. Diffusion of material at elevated temperatures is simulated by allowing exchanges of neighboring elements if the exchange lowers the total energy of the system. A Monte Carlo approach is used to select the exchange site while the change in energy associated with stress fields is computed using a finite element technique. The MCFET analysis was validated by comparing this approach with a closed form, analytical method for stress assisted, shape changes of a single particle in an infinite matrix. Sample MCFET analytical for multiparticle problems were also run and in general the resulting microstructural changes associated with the application of an external stress are similar to that observed in Ni-Al-Cr alloys at elevated temperature. Author

**N88-10940*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**THE EFFECT OF SULFUR AND ZIRCONIUM Co-DOPING ON THE OXIDATION OF NiCrAl**

James L. Smialek Oct. 1987 18 p Presented at the 172nd Meeting of the Electrochemical Society, Honolulu, Hawaii, 18-23 Oct. 1987

(NASA-TM-100209; E-3814; NAS 1.15:100209) Avail: NTIS HC A03/MF A01 CSCL 11F

The adhesion behavior of Al2O3 scales formed on NiCrAl+Zr alloys was examined as a function of both sulfur and zirconium doping levels. In general, very high levels of zirconium were required to counteract the detrimental effects of sulfur. A sulfur-zirconium adherence map was constructed, as determined from the oxidation and spalling behavior in 1100 C cyclic tests. For low sulfur alloys, the amount of zirconium required for adherence at any given sulfur level can be described by Zr greater than 600 S sup 0.2 (in ppma). These results underscore the importance of sulfur to adhesion mechanisms and suggests that sulfur gettering is a first order effect of reactive element additions to MCrAl alloys.

Author

**N88-10946*#** Dayton Univ., Ohio.

**MATHEMATICAL MODELLING OF SOLAR ULTRAVIOLET RADIATION INDUCED OPTICAL DEGRADATION IN ANODIZED ALUMINUM**

John D. Ruley *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 193-208 (For primary document see N88-10829 02-18)

(Contract F33615-84-C-5130)

Avail: NTIS HC A19/MF A01 CSCL 11F

**N88-11168*#** Cincinnati Univ., Ohio.

**CONSTITUTIVE MODELING FOR SINGLE CRYSTAL SUPERALLOYS**

Donald C. Stouffer, L. Thomas Dame, and N. Jayaraman *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 271-276 Prepared in cooperation with General Electric Co., Cincinnati, Ohio (For primary document see N88-11140 02-39)

(Grant NAG3-511)

Avail: NTIS HC A19/MF A01 CSCL 11F

**N88-11169*#** Connecticut Univ., Storrs.

**CONSTITUTIVE MODELING OF SUPERALLOY SINGLE CRYSTALS WITH VERIFICATION TESTING**

Eric Jordan and Kevin P. Walker (Engineering Science Software, Inc., Smithfield, R.I.) *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 277-286 (For primary document see N88-11140 02-39)

(Grant NAG3-512)

Avail: NTIS HC A19/MF A01 CSCL 11F

**N88-11178*#** Yale Univ., New Haven, Conn. High Temperature Chemical Reaction Engineering Lab.

**TURBINE AIRFOIL DEPOSITION MODELS AND THEIR HOT CORROSION IMPLICATIONS**

D. E. Rosner and R. Nagarajan *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 373-381 (For primary document see N88-11140 02-39)

(Grant NAG3-590)

Avail: NTIS HC A19/MF A01 CSCL 11F

**N88-11179*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**EXPERIMENTAL VERIFICATION OF VAPOR DEPOSITION RATE THEORY IN HIGH VELOCITY BURNER RIGS**

Suleyman A. Goekoglu (Case Western Reserve Univ., Cleveland, Ohio.) and Gilbert J. Santoro *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 383-390 (For primary document see N88-11140 02-39)

Avail: NTIS HC A19/MF A01 CSCL 11F

**N88-11180*#** General Electric Co., Cincinnati, Ohio.

**EFFECTS OF SURFACE CHEMISTRY ON HOT CORROSION LIFE**

R. E. Fryxell and G. E. Leese *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 391-396 (For primary document see N88-11140 02-39)

(Contract NAS3-23926)

Avail: NTIS HC A19/MF A01 CSCL 11F

# 27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

**N88-10941#** Ytong A.G., Schrobenhausen (West Germany).

**DEVELOPMENT OF HIGHLY POROUS CALCIUM SILICATE HYDRATE MATERIALS WITH EXTREMELY LOW THERMAL CONDUCTIVITY Final Report, Sep. 1985**

Klaus Friedrich Lippe Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 104 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn, West Germany

(BMFT-FB-T-86-164; ISSN-0340-7608; ETN-87-90563) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, Fed. Republic of Germany DM 20

The macrostructure and microstructure of porous calcium-silicate materials were modified for the development of building materials with very low thermal conductivity, without detrimental effects to other important construction properties. The thermal conductivity of aerated lightweight concrete (ALC) can be

influenced by varying the ratio between quarzite and binders. Only impurity ions in the form of alkalies reduce the thermal conductivity, but they also deteriorate other quality characteristics. Other impurity ions are only able to modify properties like strength, shrinkage, etc. The use of waste materials, e.g., fly ash, can reduce the thermal conductivity, but the resulting strength problem is not solved. The effect of porosity on the thermal conductivity of ALC is within the test scatter. Test results partly confirm the theoretical assumptions. ESA

**N88-10942#** Sandia National Labs., Albuquerque, N. Mex.
**CHEMICAL VAPOR DEPOSITION OF B6P AND B6As FILMS**
Terrance L. Aselage 1987 3 p Presented at the 172d Meeting of the Electrochemical Society, Honolulu, Hawaii, 18-23 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-009288; SAND-87-1098C; CONF-871027-11) Avail: NTIS HC A02

Boron phosphide and boron arsenide films are deposited on Si (100) surfaces using hydrogen reduction of chloride reactants. The deposition system utilizes a quartz bell jar in a vertical configuration. The Si wafer is placed on a B4C-coated graphite susceptor. The susceptor is heated by RF induction and the temperature of the susceptor is monitored with an optical pyrometer. The susceptor temperature was held at 1200 C and the hydrogen flow at 2.5 l/min. The boron trichloride flow was fixed at 1.5 sccm, while the phosphorus trichloride flow was varied from 3- to 6-fold excess. Deposition times from 5 to 45 minutes have resulted in B6P films ranging from approx. =1000 A to 1.2 microns in thickness, with a linear deposition rate of about 250 A/min. Thin films are transparent, while thicker films are cloudy in appearance. Chemical vapor deposition has been shown to produce B6P films on Si that are highly oriented and transparent. DOE

**N88-10943#** Lawrence Livermore National Lab., Calif.
**OPTICAL DAMAGE IN POLYMERS BY MILLISECOND LIGHT PULSES**
C. R. Wolfe, J. H. Campbell, R. E. Lyon, J. H. Pitts, and H. T. Powell Nov. 1986 31 p Presented at the Symposium on Optical Materials for High Power Lasers, Boulder, Colo., 3-5 Nov. 1986
(Contract W-7405-eng-48)
(DE87-013106; UCRL-95283; CONF-861124-2) Avail: NTIS HC A03/MF A01

Optical damage in epoxy based polymers used to attach absorbing cladding onto the edge of laser disks of the Nova Laser has been studied. Damage was produced by exposing the polymers to a 20 to 40 J/cm$^2$ fluence of broad band Xe-flashlamp light having a pulse length of approximately 0.5 ms. This simulates the flashlamp light used to pump high power Nd:glass laser amplifiers. The predominant damage mechanisms appear to be pyrolysis, associated with absorbing inclusions and photolysis, associated with intrinsic absorption of the polymer. The amount of damage can be minimized be careful filtering of the polymer to reduce the presence of foreign material and by minimizing the near UV absorption of the polymer and the UV emission of the flashlamps. DOE

**N88-10944#** Lawrence Livermore National Lab., Calif.
**RHEOLOGICAL AND AGING CHARACTERIZATION OF ELASTOMERS**
W. W. Feng 1 Jan. 1987 11 p Presented at the International Conference on Environmental Degradation of Engineering Materials, University Park, Pa., 13 Apr. 1987
(Contract W-7405-eng-48)
(DE87-009598; UCRL-94146; CONF-870466-3) Avail: NTIS HC A02/MF A01

We developed a constitutive equation for the viscoelastic and aging characteristics of elastomers subjected to large deformations. An experiment is designed for determining these mechanical properties quantitatively. DOE

**N88-10945#** Oak Ridge National Lab., Tenn.
**APPLICATIONS AND LIMITATIONS OF DEUTERIUM LABELING METHODS TO NEUTRON SCATTERING STUDIES OF POLYMERS**
G. D. Wignall and F. S. Bates 1987 19 p Presented at the 10th Discussion Conference on Small-Angle Scattering and Related Methods, Prague, Czechoslovakia, 13 Jul. 1987 Prepared in cooperation with Bell Labs., Murray Hill, N.J.
(Contract DE-AC05-84OR-21400)
(DE87-012936; CONF-870747-1) Avail: NTIS HC A03/MF A01

Deuterium labeling techniques have been widely used to study polymer chain configuration and motion, based on the assumption that the H- and D- chains are thermodynamically identical and that the interaction parameter between them, chi sub HD is zero. By an appropriate choice of the degree of polymerization and temperature, both critical scattering and phase separation can be made to occur, due solely to the small but finite thermodynamic differences between protonated and deuterated molecules. These experiments helped delineate the range of validity of the assumptions which had been used hitherto in neutron scattering studies of polymers. The majority of previous experiments, carried out at modest molecular weights, have been shown to be in large part unaffected by such effects. DOE

**N88-10946#** Oak Ridge National Lab., Tenn.
**SMALL-ANGLE NEUTRON SCATTERING (SANS) FROM POLYMERS AND COLLOIDS**
J. B. Hayter 1987 14 p Presented at the Neutron Scattering Symposium on Advances and Applications, Sydney, Australia, 8 Aug. 1987
(Contract DE-AC05-84OR-21400)
(DE87-013548; CONF-8708117-1) Avail: NTIS HC A03/MF A01

Small-angle neutron scattering (SANS) has been remarkably successful in providing detailed quantitative structural information on complex everyday materials, such as polymers and colloids, which are often of considerable industrial as well as academic interest. This paper reviews some recent SANS experiments on polymers and colloids, including ferrofluids, and discusses the use of these apparently complex systems as general physical models of the liquid or solid state. DOE

**N88-10947#** Oak Ridge National Lab., Tenn.
**NEEDS ASSESSMENT FOR NDT AND CHARACTERIZATION OF CERAMICS: ASSESSMENT OF INSPECTION TECHNOLOGY FOR GREEN STATE AND SINTERED CERAMICS**
R. W. McClung and D. R. Johnson 1987 19 p Presented at the Conference on Nondestructive Testing of High Performance Ceramics, Boston, Mass., 25 Aug. 1987
(Contract DE-AC05-84OR-21400)
(DE87-013550; CONF-870856-1) Avail: NTIS HC A03/MF A01

A needs assessment was found for nondestructive testing and materials characterization to achieve improved reliability in ceramic materials for heat engine application. Considered were raw materials, green state bodies, and sintered ceramics. This paper discusses applications of nondestructive testing to green state and sintered ceramics. Included are identification of critical characteristics that affect material properties and performance, potential examination techniques, and the results of prior studies of technique applications to ceramic materials. DOE

**N88-10948#** Oak Ridge National Lab., Tenn.
**EXELFS (EXTENDED ELECTRON ENERGY LOSS FINE STRUCTURE) OF AMORPHOUS AND CRYSTALLINE SiC**
P. Angelini, J. C. Sevely, K. Hssein, and G. Zanchi Jul. 1987 10 p Presented at the Pacific Workshop and Meeting on Analytical Electron Microscopy, Kona, Hawaii, 12 Jul. 1987 Prepared in cooperation with Centre National de la Recherche Scientifique, Toulouse, France
(Contract DE-AC05-84OR-21400)
(DE87-013551; CONF-870733-10) Avail: NTIS HC A02/MF A01

Extended Electron Energy Loss Fine Structure (EXELFS) is a technique which is sensitive to the local atomic environment surrounding atoms. The ability to perform EXELFS measurements with the use of an electron microscope enables one to study materials properties at high spatial resolution. Its use as a method to evaluate amorphous materials is especially noteworthy since EXELFS is sensitive to the structure and composition within near neighbor distances of specific types of atoms. The materials used in this study included single crystal SiC, single crystal SiC made amorphous by ion implantation with chromium, and single crystal SiC made amorphous under a converged 300 kV electron beam. EXELFS results, based on the Si K edge, exhibit significant differences for crystalline SiC versus ion implanted amorphous SiC. The position of peaks in the Radial Distribution Function (RDF), representing the Si-C and the Si-Si interatomic bonds, indicate an expansion in the nearest neighbor distances for the ion implanted amorphous SiC. Also the Si-Si/Si-C peak intensity ratio for the amorphous material was significantly lower than that for crystalline SiC. These results imply that the tetrahedral (Si-C) bonds are retained to a greater degree than the longer Si-Si bonds. A loss in coordination of the Si-Si bond indicates that the unit cell has undergone substantial damage. DOE

**N88-10949#** Michigan Technological Univ., Houghton. Dept. of Physics.
**THEORY OF DEFECTS IN NON-METALLIC SOLIDS Progress Report, 1 Aug. 1986 - 31 Jul. 1987**
A. B. Kunz Jul. 1987 37 p
(Contract DE-FG02-85ER-45224)
(DE87-014068; DOE/ER-45224/T1) Avail: NTIS HC A03/MF A01

A general method based upon ab initio quantum mechanical modelling and also using the semi-classical models based upon the concepts introduced by Mott and Littleton in 1938 are being implemented to provide a general theoretical approach to the study of point defects and impurities in non-metals. This model treats the impurity electronic structure and the lattice response to the impurity in a self-consistent way. Thus charge states of defects and impurities are readily studied as is the energy stability of the several states of charge. This project has resulted in a general, FORTRAN computer code called ICECAP. A functioning code has been generated to implement these ideas. Basic concepts have now been well validated in actual calculations. Studies have been performed on several alkali-halides and MgO. The first complete defect study, for Cu impurity in NaF, is also complete. This study demonstrates the need for incorporation of lattice response to a defect if accurate energies are to result, as well as a need to improve efficiency of a few parts of the ICECAP automated process as well. Finally, initial studies on the V sub k center in LiF are underway as are studies of the self-trapped excision in this system. DOE

**N88-10950#** Rensselaer Polytechnic Inst., Troy, N.Y. Dept. of Materials Engineering.
**MECHANISM OF MECHANICAL FATIGUE OF FUSED SILICA Progress Report, 1 Jul. 1985 - 31 Aug. 1987**
M. Tomozawa Sep. 1987 7 p
(Contract DE-FG02-85ER-45217)
(DE87-014199; DOE/ER-45217/3) Avail: NTIS HC A02/MF A01

Various experiments were conducted to find out the correct mechanism for the mechanical fatigue of silica glass. First, it was shown that a crack tip in silica glass can be made blunt by appropriate thermal and chemical treatments. Furthermore, it was shown that the fatigue behavior of the treated glass with blunt cracks involves crack initiation, in addition to crack growth, while that of the freshly abraded glass with sharp cracks can be explained by slow crack growth only. Crack initiation under a subcritical stress was possible only in the presence of water and ammonia, while crack propagation can take place in the presence of other chemicals such as formamide and hydrazine also. Water and possibly ammonia enter the glass under stress and the entry of these chemicals appears to be responsible for crack initiation. DOE

**N88-10951#** Pennsylvania State Univ., University Park.
**HYDROGEN ANNEALING OF P(SUB) b AND E PRIME DEFECT CENTERS IN OXIDIZED SILICON WAFERS**
Zheng Li, S. J. Fonash, P. J. Caplan, and E. H. Poindexter (Army Electronics Technology and Devices Lab., Fort Monmouth, N. J.) 1987 10 p Presented at the 1st Workshop on Process-Related Electrically Active Defects in Semiconductor-Insulator Systems, Research Triangle Park, N.C., 1 Sep. 1987 Prepared in cooperation with Brookhaven National Lab., Upton, N.Y.; Army Electronics Technology and Devices Lab., Fort Monmouth, N.J.
(Contract DE-AC02-76CH-00016)
(DE87-014293; BNL-40106; CONF-8709121-1) Avail: NTIS HC A02/MF A01

The disposition of hydrogen and hydrogeneous species in the oxide of MOS devices is a major factor in resistance to hot-electron injection, high-voltage stress, and ambient radiation. There is a need for spectroscopically based modeling of the thermochemical generation and annealing of defects. This paper presents preliminary results on the hydrogen annealing of the P sub b (.Si identical to Si sub 3) interface defect and the E prime (.Si identical to O sub 3) oxide defect. DOE

**N88-10952#** Nevada Univ., Reno. Dept. of Chemistry.
**THE INFLUENCE OF POLYMER STRUCTURE ON TRIPLET LUMINESCENCE**
R. D. Burkhart and J. A. J. Burrows 1987 2 p Presented at the 194th American Chemical Society National Meeting, New Orleans, La., 30 Aug. 1987
(Contract DE-FG08-84ER-45107)
(DE87-014431; DOE/ER-45107/6; CONF-870802-12) Avail: NTIS HC A02

Triplet luminescence spectroscopy has been used to probe interactions between pendant groups of polymer chains. A styrene polymer was synthesized with naphthyl and phenylcarbonyl chromophores at the terminal positions. Information about inter- and intramolecular energy transfer was obtained from phosphorescence spectra in MTHF solutions at 77 K. DOE

**N88-10953#** Nevada Univ., Reno. Dept. of Chemistry.
**MIGRATION AND TRANSFER OF TRIPLET ENERGY IN SELECTED POLYMER SYSTEMS**
R. D. Burkhart and J. A. J. Burrows 1987 10 p Presented at the 13th International Conference on Photochemistry, Budapest, Hungary, 9 Aug. 1987
(Contract DE-FG08-84ER-45107)
(DE87-014432; DOE/ER-45107/5; CONF-8708118-1) Avail: NTIS HC A02

Triplet energy transfer has been investigated in specially synthesized polymers consisting of a polystyrene main chain but with an aromatic carbonyl group located at one end of the chain and an naphthalene group at the other. Excitation at 337 nm selectively excites the aromatic carbonyl chromophore, and the spectroscopic evidence suggests that a part of this excitation energy becomes localized in the phenyl groups of the polymer chain. The mechanism for this process probably involves a spin forbidden singlet to triplet energy transfer which becomes partially allowed due to the strong spin-orbit coupling which exists at the aromatic carbonyl chromophore. Kinetic measurements of the luminescence decay of the phenyl group phosphorescence were made for polymers synthesized with and without the terminating naphthalene group. Decay rates were nearly three times as fast for those polymers containing the naphthalene group suggesting that some communication exists between chain ends. All luminescence measurements were made at 77 K in 2-methyl tetrahydrofuran. DOE

**N88-10954#** New York Univ., New York. Radiation and Solid State Lab.
**THE PHOTOPHYSICS AND CHEMISTRY OF PAH (POLYCYCLIC AROMATIC HYDROCARBONS) COMPOUNDS Progress Report, 1 Sep. 1985 - 31 Aug. 1987**
N. E. Geacintov 1987 88 p
(Contract DE-FG02-86ER-60405)
(DE87-014455; DOE/ER-60405/2) Avail: NTIS HC A05/MF A01

Research progress is reported in the following areas: (1) photoemission from particulate matter suspended in a gaseous atmosphere; (2) model heterogeneous chemical reactions - PAH/atomic oxygen; (3) electrochemistry at solid PAH/aqueous electrolyte interfaces; (4) energy transfer mechanisms in organic crystals; and (5) biological damage by PAH and nitro-PAH compounds: interactions with DNA. DOE

**N88-10955#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**STRESS MEASUREMENTS IN SOL-GEL FILMS**
K. A. Cerqua, J. E. Hayden, and W. C. LaCourse Sep. 1987 19 p Presented at the International Conference of Glass and Glass-Ceramics, Kyoto, Japan, 12 Jul. 1987
(Contract DE-FC08-85DP-40200)
(DE87-014467; DOE/DP-40200/57; CONF-8707101-1) Avail: NTIS HC A03/MF A01

Thin solid films of a wide variety of materials have received increased attention during the past decade. These films have been instrumental in the growth of numerous technologies. Until recently, thin films have primarily described layers of metallic or dielectric materials deposited onto substrates by evaporation, electron beam or ion beam techniques. Advances in sol-gel technology have extended film research to include glassy materials of either crystalline, or amorphous nature. Sol-gel films can be tailor-made to accommodate a diverse range of applications due primarily to flexibility in chemical make up which determines the respective film's structure. One important characteristic of such films is their inherent residual stress. This inherent stress, and the stress the film introduces to the substrate as it is deposited, can result in a complex stress profile. While thin in the case of sol-gel films generally means less than 1 micron in thickness, large (10 to 100's of nm of retardance) inherent stress per unit thickness can severely limit a film's performance and subsequent application. Described is an effort to quantify the residual stress in silica-based sol-gel films as a function of several processing parameters. DOE

**N88-10956#** Lawrence Livermore National Lab., Calif.
**OPTICAL CHARACTERIZATION OF SILICA AEROGEL GLASS**
L. W. Hrubesh Jul. 1987 25 p
(Contract W-7405-eng-48)
(DE87-014617; UCRL-53794) Avail: NTIS HC A03/MF A01

This report compares several techniques that have been used to optically characterize porous silica aerogel glass. These techniques are accurate and rapid, and they provide excellent alternatives to nonoptical methods for the nondestructive evaluation of silica aerogel material. DOE

**N88-10957#** Oak Ridge National Lab., Tenn.
**NEEDS ASSESSMENT FOR NONDESTRUCTIVE TESTING AND MATERIALS CHARACTERIZATION FOR IMPROVED RELIABILITY IN STRUCTURAL CERAMICS FOR HEAT ENGINES**
D. R. Johnson, R. W. McClung, M. A. Janney, and W. M. Hanusiak Aug. 1987 91 p
(Contract DE-AC05-84OR-21400)
(DE88-000040; ORNL/TM-10354) Avail: NTIS HC A05/MF A01

A needs assessment was performed for nondestructive testing and materials characterization to achieve improved reliability in ceramic materials for heat engine applications. Raw materials, green state bodies, and sintered ceramics were considered. The overall approach taken to improve reliability of structural ceramics requires key inspections throughout the fabrication flowsheet, including raw materials, greed state, and dense parts. The applications of nondestructive inspection and characterization techniques to ceramic powders and other raw materials, green ceramics, and sintered ceramics are discussed. The current state of inspection technology is reviewed for all identified attributes and stages of a generalized flowsheet for advanced structural ceramics, and research and development requirements are identified and listed in priority order. DOE

**N88-10958#** Laboratoire Central des Ponts et Chaussees, Paris (France). Div. Materiaux de Chaussees.
**POLYMER MODIFIED BINDERS FOR BITUMINOUS OR ASPHALTIC PAVING LAYERS [LIANTS MODIFIES PAR DES POLYMERES POUR ENDUITS ET ENROBES SPECIAUX]**
Bernard Brule Feb. 1987 60 p In FRENCH
(PC-5; ISBN-2-7208-3531-5; ISSN-0755-2351; ETN-87-90647)
Copyright Avail: NTIS HC A04/MF A01

The state of the art in polymer modified binders is reviewed. The survey includes theoretical aspects of hydrocarbon binder properties modification, the nature of the changes induced by thermoplastic polymer addition, special procedures (such as the addition of rubber powder), utilization problems, and application domains. ESA

**N88-10959#** Institut National des Sciences Appliquees de Lyon, Villeurbanne (France).
**UREA-POLYURETHANE AND POLYDIMETHYLSILOXANE MIXTURES. MORPHOLOGY CONTROL USING A BLOCK COPOLYMER Ph.D. Thesis [MELANGES DE POLYURETHANNES-UREES ET DE POLYDIMETHYLSILOXANES. CONTROLE DE LA MORPHOLOGIE PAR UN COPOLYMERE A BLOCS]**
Philippe Knaub 1987 173 p In FRENCH
(ISAL-IDI1-87-05; ETN-87-90897) Avail: NTIS HC A08/MF A01

The synthesis of polyurethane-urea resins is described. The properties of the resulting elastomer are due to the use of a heavy diamine molecule which diminishes the reactivity of the amine groups and keeps a high cohesion of the formed rigid segments. These elastomers are shown to be usable up to 250 C. A polydimethylsiloxane network was introduced as a demolding agent. As these two polymers are not miscible, an emulsifying agent was incorporated. It is a block copolymer, used in a proportion 0.5 to 2 percent, and it improves considerably the overall properties. ESA

**N88-10960#** Institut National des Sciences Appliquees de Lyon, Villeurbanne (France).
**STUDY OF THE MICROMECHANICAL BEHAVIOR OF A SIO2-AI2O3-LI2O GLASS CERAMIC AND ITS RELATION TO THE MICROSTRUCTURE Ph.D. Thesis [ETUDE DU COMPORTEMENT MICRO-MECANIQUE D'UNE VITROCERAMIQUE A BASE DE SIO2-AL2O3-LI2O EN LIAISON AVEC LA MICROSTRUCTURE]**
Hamid Satha 1987 138 p In FRENCH
(ISAL-ITC1-87-01; ETN-87-90899) Avail: NTIS HC A07/MF A01

The anelastic or viscoplastic behavior of glass ceramics was studied relating mechanical characteristics to the evolution of the microstructure towards a growing cristallinity. Low angle X-ray diffraction and transmission electron microscopy were used to characterize crystal growth. Seeding is found to be generated by ZrTiO4 precipitation. The correlation of the evolution of mechanical properties to the development of crystallinity is demonstrated. ESA

**N88-10961#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique des Materiaux.
**STUDY OF THE MORPHOLOGY OF THERMOSETTING MATRICES [ETUDE DE LA MORPHOLOGIE DES MATRICES THERMODURCISSABLES]**
A. J. Attias and B. Bloch Feb. 1987 45 p In FRENCH
(Contract DRET-85-34-001)

(ONERA-RT-5/3346-M; ETN-87-90904) Avail: NTIS HC A03/MF A01

The visualization of molecular functional groups is developed, in order to study the three dimensional structure of reacted epoxy resin matrices of the type used in the aerospace industry. High resolution electron microscopy and nuclear magnetic resonance techniques were used. It is found that the use of transmission electron microscopy on ultrathin colored specimens allows the determination of the space distribution of the functional groups. ESA

**N88-10962#** Rolls-Royce Ltd., Derby (England).
**THE EFFECT OF TEMPERATURE ON FATIGUE CRACK INITIATION FROM ALUMINOSILICATE INCLUSIONS**
P. Woollin and J. F. Knott (Cambridge Univ., England ) 28 Jun. 1987 14 p Presented at the Fatigue 87 Conference, Charlottesville, Va., 28 Jun. - 3 Jul. 1987
(PNR90377; ETN-87-90993) Copyright Avail: NTIS HC A03/MF A01

Fatigue cracks were observed to initiate and grow from aluminosilicate inclusions in powder formed alloy AP-1 at stress intensities below the long crack threshold, in air and under vacuum. Measured crack growth rates lie below short crack growth rate data for Astroloy under similar conditions. This is consistent with the presence of residual, tessellated stress fields associated with the inclusions. In vacuum, higher crack growth rates are observed at 600 C than at 20 C. Transition from stage 1 to stage 2 crack growth occurs at lower applied delta k levels at 600 C than 20 C. These effects are related to the reduction of the residual stresses with increasing temperature. ESA

**N88-10963#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Reaktorwerkstoffe.
**COMPARISON OF HIGH PURITY FINE GRAIN GRAPHITES FROM DIFFERENT SUPPLIERS WITH REGARD TO PHYSICAL, MECHANICAL, AND THERMAL PROPERTIES Final Report**
Wolfgang Delle, Jochen Linke, Hubertus Nickel, and Erich Wallura May 1987 158 p
(Contract JD4/9009)
(JUEL-Spez-401; ISSN-0343-7639; ETN-87-91029) Avail: NTIS HC A08/MF A01

Thermal shock resistance of eight fine grain graphites was tested in single shot experiments in an electron beam welding machine. A carbon fiber composite material was also tested. Apparent density; total and open porosity; electrical resistivity between room temperature and 1000 C; thermal conductivity between 100 and 1000 C; linear thermal expansion between room temperature and 1000 C; dynamic Young's modulus; and bending strength and fracture deflection were determined. Materials EY-306, FP-219, and E-5923 P (electron beam vertical to the fiber planes) show the highest weight loss values. Relatively low amounts of eroded material in all series are found for EK 98, ATJ, FE-289, and E-5923 P (electron beam parallel). The graphite AXF-5 Q shows the worst cracking behavior, followed by EY-306. Excellent thermal shock behavior is detected for the materials FP-219, ATJ, and the carbon fiber composite E-5923 P. ESA

**N88-10964#** Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Material- und Festkoerperforschung.
**CRACK BEHAVIOR IN CERAMIC MATERIALS UNDER STATIC, SLOWLY INCREASING, AND CYCLIC LOADING CONDITIONS Thesis - Karlsruhe Univ., West Germany**
Nikolaus Brugger Jun. 1987 144 p In GERMAN; ENGLISH summary
(KfK-4209; ISSN-0303-4003; ETN-87-91030) Copyright Avail: NTIS HC A07/MF A01

Crack growth studies were realized with simple, easily producible cantilever specimens predamaged by a bridge method. The behavior of these macroscopic, naturally sharp cracks was studied under static, dynamic, and cyclic conditions. The existence and determination of stress intensity factor K(IO) which leads to solid crack stagnation under various loading conditions are shown. Particulary under cyclic loading, slow crack growth starts up to 50% of K(Imax). Therefore the stress intensity factors K(IOschw) should be used for safe ceramic construction, where no crack extension even after 10 million load cycles take place. Increasing crack resistance with increasing crack length, known from alumina, is also shown by Si3N4 and SiC-materials. Crack opening and crack growth show clear indications of friction effects behind the crack tip opposed to the frequently postulated process zone model. The positive influence of rough crack walls leads to suggestions for ceramic materials with higher crack resistance and increased fracture toughness. ESA

**N88-10965*#** National Aeronautics and Space Administration, Washington, D.C.
**PREPARATION OF OXIDE GLASSES FROM METAL ALKOXIDES BY SOL-GEL METHOD**
K. Kamiya, T. Yoko, and S. Sakka Nov. 1987 23 p Transl. into ENGLISH from Yogyo Kyokaishi (Japan), v. 92, no. 5, 1984 p 242-247 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Prepared by Mie Univ. (Japan)
(Contract NASw-4005)
(NASA-TT-20124; NAS 1.77:20124) Avail: NTIS HC A03/MF A01 CSCL 11B

An investigation is carried out on the types of siloxane polymers produced in the course of the hydrolysis of silicon tetraethoxide, as well as the preparation of oxide glasses from metal alkoxides by the sol-gel method. Author

**N88-10966*#** National Aeronautics and Space Administration, Washington, D.C.
**EXPERIMENTS OF THE SELECTION OF A METHOD EVALUATING THE FIRE RESISTANCE OF SOME MATERIALS BASED ON MACROMOLECULAR COMPOUNDS**
Stein Stoica and Mircea Octavian Sebe Oct. 1987 12 p Transl. into ENGLISH from Materiale Plastice (Bucharest, Romania), v. 16, no. 3, 1979 p 175-178 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-4005)
(NASA-TT-20129; NAS 1.77:20129) Avail: NTIS HC A03/MF A01 CSCL 11B

A comparative experimental study on the application of various tests for the evaluation of the fire-resistant properties of plastic materials is presented. On the basis of the results obtained conclusions are drawn on the advantages and disadvantages of the methods used, and a preferred test method is picked, i.e., the introduction of fire retardant materials into the polymers. Author

## 28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

**N88-10967#** Sandia National Labs., Albuquerque, N. Mex.
**PYROTECHNIC COMPONENT DEVELOPMENT AT SANDIA NATIONAL LABORATORY**
Paul D. Wilcox 1987 7 p Presented at the International Symposium on Pyrotechnics and Explosives, Beijing, People's Republic of China, 12 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-006899; SAND-87-0618C; CONF-871040-2) Avail: NTIS HC A02/MF A01

Pyrotechnic and explosive devices are designed at Sandia National Laboratories, SNL, which must satisfy high reliability requirements for reliable function and storage life. Since only a small number of devices may be built, high standards of quality of both the explosive and structural materials are necessary. We have developed special alloys and glass-ceramic seals for headers and structural parts of these devices to satisfy requirements for minimum size and weight but with increased ruggedness and safety. Hermetic sealing is used extensively to aid in the control of

corrosion and aging effects. There is an increasing demand for the integration of these devices with safer (less sensitive) materials, better handling methods, and the use of electrical or fiber optic logic input elements. This paper addresses the trends in active materials, structural materials and a new method of ignition which enhances device designs compatible with low voltage and digital electronics. DOE

**N88-10968#** Lawrence Livermore National Lab., Calif.
**HOT SPOTS: SUBNANOMETER FEMTOSECOND ENERGY LOCALIZATION**
A. M. Karo and J. R. Hardy (Nebraska Univ., Lincoln.) Dec. 1986 7 p Presented at the 11th International Colloquium on Dynamics of Explosions and Reactive Systems, Warsaw, Poland, 2-7 Feb. 1987 Sponsored in part by ONR
(Contract W-7405-eng-48)
(DE87-010276; UCRL-95811; CONF-8702103-1) Avail: NTIS HC A02/MF A01

In a condensed energetic material an understanding of the dynamics and microscopic mechanisms underlying energy transfer between a shock front and various defects is of prime importance for a realistic description of hot spot formation and explosives initiation. A wide variety of simulations using the well-established technique of computer molecular dynamics has enabled us to obtain a general and very useful microscopic description of the processes beneath the macroscopic behavior of shocked systems. The calculation of the influence of heterogeneities such as point and line defects, voids, and grain boundaries is made possible by computer codes that can handle totally heterogeneous dynamical systems and track the dynamics of energy concentration and partitioning among the molecular bonds in the defect and the nearby region. One and two-dimensional calculations will be discussed in which the spatial and temporal dependence of the energy flux in a general lattice-defect system is calculated quantitatively as a function of shock strength, initial temperature, and initial parameters defining the lattice and defect. DOE

**N88-10969#** Sandia National Labs., Albuquerque, N. Mex. Engineering Applications Dept.
**JET FORMATION AND CHARACTERIZATION OF A CONICAL SHAPED CHARGE**
Jerome H. Stofleth and Rodney N. Owenby 1987 14 p Presented at the 31st SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012102; SAND-87-1273C; CONF-8708110-5) Avail: NTIS HC A03/MF A01

A Conical Shaped Charged (CSC) is an explosive assembly used as a single point penetrator in applications ranging from commercial to national defense. The formation, flight characteristics, and penetration effects of the CSC are of great importance to its users. Because of the extreme velocities of the shaped charge jet, high speed documentation was necessary to research CSC effects. By use of closure switches and initial velocity studies, framing and lighting information for the Cordin 114 Ultra High Speed camera was determined. After the initial data were gathered, it was determined that another source of documentation was necessary. A Hewlett Packard 150 kilovolt flash X-ray system was implemented, enabling more accurate velocity measurements and a better understanding of jet formation and the CSC during flight. Both techniques of documentation were invaluable in the characterization and research of the conical shaped charge. DOE

**N88-10970#** Sandia National Labs., Albuquerque, N. Mex.
**VISIBLE EMISSION FROM GRANULAR EXPLOSIVES DURING SHOCK INITIATION**
Robert E. Setchell 1987 5 p Presented at the 5th Topical Conference of the Am erican Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012361; SAND-87-1244C; CONF-870753-24) Avail: NTIS HC A02/MF A01

The current work illustrates how visible emission from an explosive/window interface can be used to qualitatively examine chemical energy release during shock wave growth towards detonation. The integrated intensity measurements show temporal and spatial properties of the energy release. The emission spectra show definite features, although identification of emitting species is difficult. DOE

**N88-10971#** Lawrence Livermore National Lab., Calif.
**THE EQUATION OF STATE OF PETN DETONATION PRODUCTS**
L. G. Green, E. L. Lee, D. Breithaupt, and J. Walton 28 Jul. 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract W-7405-eng-48)
(DE87-013796; UCRL-96497; CONF-870753-67) Avail: NTIS HC A02/MF A01

We have made shock Hugoniot and expansion measurements on the detonation products of PETN over the range .5 to 114 GPa. We find that for PETN (relatively oxygen rich as opposed to most other explosives) CJ measurements, expansion measurements and supra-compression measurements are consistent with a time independent EOS. In this paper we have compared these results with various equation of state descriptions. The results are The Equation of State of PETN Detonation Products. DOE

**N88-10972#** Sandia National Labs., Albuquerque, N. Mex.
**SPECTROSCOPIC STUDIES OF SHOCKED AND DETONATING EXPLOSIVES**
A. M. Renlund and W. M. Trott 1987 6 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-014216; SAND-87-0927C; CONF-870753-70) Avail: NTIS HC A02/MF A01

Real-time observation techniques including single-pulse Raman scattering, time-resolved infrared spectral photography, emission spectroscopy and fast-framing photography have been used to study chemical and physical changes in shock-loaded and detonating explosive materials. Experiments have focused on how material variables such as density and particle size may affect emission characteristics in detonating high explosives (HEs). We have also studied effects of pressure and temperature on vibrational frequencies in shocked HEs. DOE

**N88-10973#** Oak Ridge National Lab., Tenn.
**FIFTY YEARS IN SYNTHETIC FUELS INFORMATION: HAVE WE LOST A STRATEGIC NATIONAL RESOURCE**
L. M. Roseberry 1987 13 p Presented at the American Society for Information Science's Annual Meeting, Boston, Mass., 4 Oct. 1987
(Contract DE-AC05-84OR-21400)
(DE87-010902; CONF-871089-1) Avail: NTIS HC A03/MF A01

The recent 50-year history of the synthetic fuels industry is a long saga of fluctuating national interest, funding, and precipitous world events. The goal of a unified information set has been seriously compromised by war and shortages, prosperity and apathy, economic conflict and OPEC, and a return to abundant supply. On the horizon looms the dismal prospect of a real and permanent energy shortage, a prospect that easily justifies the need for keeping important technical information for the future. This paper tells the tale of the research literature from the German experience during World War II through the disbanding of the Synthetic Fuels Corporation. DOE

**N88-10974#** Christian Rovsing Ltd., Copenhagen (Denmark). Aerospace Systems Dept.
**A NONDISSIPATIVE PYROTECHNIC ARMING AND FIRING UNIT (PAFU) Final Report**

M. Heisel Paris, France ESA 2 Sep. 1987 179 p
(Contract ESA-5393/83-NL-BI(SC))
(CRA/REPO/8019; ESA-CR(P)-2434; ETN-87-90890) Avail: NTIS HC A09/MF A01

A representative section of a nondissipative pyrotechnic arming and firing unit was designed. An overall pyrotechnic system design concept, compatible with the requirements for Ariane and space shuttle launchers and launch sites was established. The design is adaptable and reusable on most spacecraft programs. ESA

**N88-10975#** SRI International Corp., Menlo Park, Calif.
**REDUCTION OF CO2 TO METHANOL AND METHANE BY PHOTO AND DARK REACTIONS ON SEMICONDUCTOR AND METAL ELECTRODES Annual Report, 15 Feb. 1986 - 28 Feb. 1987**
K. W. Frese, D. P. Summers, and J. J. Kim 30 Apr. 1987 74 p
(Contract GRI-5083-260-0922)
(PB87-226825; GRI-87/0101) Avail: NTIS HC A04/MF A01 CSCL 07D

The electrochemical reduction of aqueous CO2 was studic using Ru cathodes. The rate of methane formation is controlled by temperature, electrolyte pH, and impurities in the electrolyte. Electrode surfaces are deactivated at t greater than 80 C by the formation of surface carbon. Methane formation is observed for potentials negative of -0.40V (SCE) at pH 4.0. Chlorine is a poison for the methane reaction. GRA

**N88-10976#** General Accounting Office, Washington, D. C. Resources, Community and Economic Development Div.
**ALTERNATIVE FUELS: INFORMATION ON DOD'S (DEPARTMENT OF DEFENSE'S) METHANOL VEHICLE PROGRAM**
May 1987 16 p
(PB87-213328; GAO/RCED-87-91; B-226783) Avail: NTIS HC A03/MF A01 CSCL 07D

The GAO evaluated the Department of the Army's progress toward achieving the goals of the Department of Defense (DOD) methanol vehicle demonstration program. The Army initiated the program in February 1985, in response to White House and congressional interest, to establish the feasibility of using methanol as an alternative fuel for government vehicles. Army efforts to accomplish the goals established in the authorizing legislation are reviewed, i.e., (1) to procure new methanol vehicles; (2) to establish the reliability and durability of such vehicles in laboratory and fleet tests; (3) to test some of them in cold weather; and (4) to resolve related support functions for the safe and efficient storage, distribution, and use of methanol fuel. GRA

# 29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology.*

**N88-10977*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**PREPARATIVE ELECTROPHORESIS FOR SPACE**
Percy H. Rhodes and Robert S. Snyder Oct. 1987 15 p
(NASA-TP-2777; NAS 1.60:2777) Avail: NTIS HC A03/MF A01 CSCL 22A

A premise of continuous flow electrophoresis is that removal of buoyancy-induced thermal convection caused by axial and lateral temperature gradients results in ideal performance of these instruments in space. Although these gravity dependent phenomena disturb the rectilinear flow in the separation chamber when high voltage gradients or thick chambers are used, distortion of the injected sample stream due to electrohydrodynamic effects cause major broadening of the separated bands. The electrophoresis separation process is simple, however flow local to the sample filament produced by the applied electric field have not been considered. These electrohydrodynamic flows distort the sample stream and limit the separation. Also, electroosmosis and viscous flow combine to further distort the process. A moving wall concept is being proposed for space which will eliminate and control the disturbances. The moving wall entrains the fluid to move as a rigid body and produces a constant residence time for all samples distributed across the chamber thickness. The moving wall electrophoresis chamber can only be operated in space because there is no viscous flow in the chamber to stabilize against thermal convection. Author

**N88-10978*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**CONTINUOUS FLOW ELECTROPHOREISIS SYSTEM EXPERIMENTS ON SHUTTLE FLIGHTS STS-6 AND STS-7**
Robert S. Snyder, Percy H. Rhodes, and Teresa Y. Miller Oct. 1987 17 p
(NASA-TP-2778; NAS 1.60:2778) Avail: NTIS HC A03/MF A01 CSCL 22A

A space continuous flow electrophoresis system (CFES) was developed that would incorporate specific modifications to laboratory instruments to take advantage of weightlessness. The specific objectives were to use a model sample material at a high concentration to evaluate the continuous flow electrophoresis process in the CFES instrument and compare its separation resolution and sample throughput with related devices on Earth and to expand the basic knowledge of the limitations imposed by fluid flows and particle concentration effects on the electrophoresis process by careful design and evaluation of the space experiment. Hemoglobin and polysaccharide were selected as primary samples. The results from space show a large band spread of the high concentration of the single species of hemoglobin that was due to the mismatch of electrical conductivity between the sample and the buffer. On STS-7 the major objective was to evaluate the influence of the electrical properties of the sample constituents on the resolution of the CFES. As expected, the polystyrene latex microspheres dispersed in a solution with 3 times the electrical conductivity of the curtain buffer separated with a larger band spread than in the 2nd experiment. Author

**N88-10979*#** Desert Research Inst., Reno, Nev.
**ON THE ROLE OF CONVECTIVE MOTION DURING DENDRITE GROWTH: EXPERIMENTS UNDER VARIABLE GRAVITY, REVISED Final Report**
J. Hallett, N. Cho, K. Harrison, A. Lord, E. Wedum, R. Purcell, and C. P. R. Saunders (Manchester Univ., England ) Aug. 1987 126 p
(Contract NAS8-34605)
(NASA-CR-179213; NAS 1.26:179213) Avail: NTIS HC A07/MF A01 CSCL 22A

Experiments show the effect of self induced convection on individual dendrite growth in uniformly supercooled samples and solidification of the resulting mush under conditions of high and low g. Convection is visualized by a Schlieren optical system or a Mach Zender interferometer. For ice crystals growing from the vapor in air, a slight reduction in linear growth rate occur under low g. For ice crystals growing from NaCl solution, dendrite tip velocities are unchanged, but subsequent mush solidification is enhanced through drainage channels under higher g. By contrast, sodium sulfate decahydrate dendrites growing from solution produce convective plumes which lead to higher tip growth rate only as the crystal growth direction approaches that of gravity. Convective plumes are laminar for small crystals under conditions of these experiments; the rise velocity of such plumes is greater than individual vortex rings under identical conditions. Convection effects are only present in solution under a critical supercooling less than about 5 C for sodium sulfate and 2 C for ice in NaCl since at higher supercooling the crystallization velocity, proportional to the square of the supercooling, exceeds the convective velocity, proportional to the square root of the supercooling. The role of convective velocity in bulk solidification is to give a large scale flow which under extreme cases may lead to extensive secondary crystal production, which alters the resulting crystal texture of the completely solidified melt. Author

**N88-10980#** Societe Nationale Industrielle Aerospatiale, Paris (France).
**METALLURGY LABORATORY FOR COLUMBUS, EXECUTIVE SUMMARY**
H. Sainct, F. Jamin-Changeart, and J.-P. Praizey Paris, France ESA Mar. 1987 15 p
(Contract ESA-6625/85-F-FL-SC)
(SNIAS-813-CA/TS; ESA-CR(P)-2416; ETN-87-90878) Copyright Avail: NTIS HC A03/MF A01

Three furnaces for directional solidification, artificial composites, and in situ composites for the Columbus space station microgravity environment are proposed. A gradient furnace limited to 1300 C, fully instrumented and dedicated to basic research can be accommodated in a single rack. The limited temperature leads mainly to gradient restrictions for materials with a good thermal conductivity (Al, Ag, Cu). A second, higher temperature gradient furnace, dedicated to applied research and preindustrial development, has a heating chamber with larger cavity and 2000 C maximum temperature. An isothermal furnace (2000 C maximum temperature and at least 100 mm sample diameter) is dedicated mainly to glass processes. To maximize the efficiency of such a furnace a positioning device may be implemented. The power needs of the last two furnaces are limited by the Columbus capacities, consequently they are accommodated in the same high-powered double rack and are run in sequence. ESA

**N88-10981#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).
**THERMOPHYSICAL PROPERTIES MEASUREMENT FACILITY (TPMF) Final Report**
Paris, France ESA Apr. 1987 25 p
(Contract ESA-6615/85-F-HEW(SC))
(ESA-CR(P)-2417; ETN-87-90879) Avail: NTIS HC A03/MF A01

A microgravity diffusion laboratory for the pressurized module or Man-Tended-Free-Flyer of the Columbus space station is proposed. The scientific background and experimental equipment needed in research on thermophysical properties were established. Stimuli and diagnostic units were defined. A design concept with a standard experimental chamber in triple arrangement and peripheral equipment as diagnostic instruments is elaborated. Feasibility aspects as well as required services, accommodation, and operation are covered. ESA

# 31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

**N88-10982#** Brookhaven National Lab., Upton, N. Y.
**OPERATING EXPERIENCES AND TEST RESULTS OF SIX COLD HELIUM COMPRESSORS**
D. P. Brown, R. J. Gibbs, A. P. Schlafke, J. H. Sondericker, and K. C. Wu 1987 11 p Presented at the Conference on Advances in Cryogenic Engineering, St. Charles, Ill., 14 Jun. 1987
(Contract DE-AC02-76CH-00016)
(DE87-012115; BNL-39943; CONF-8706125-7) Avail: NTIS HC A03

Three small and three large cold helium centrifugal compressors have been operated at Brookhaven National Laboratory between 1981 and 1986. The three small cold compressors have been installed on a 1000 W refrigerator for testing a string of superconducting magnets and for R and D purposes. The three large units are components of the BNL 24.8 KW refrigerator to be used to provide cooling for the RHIC project. These compressors are used either to circulate a large amount of supercritical helium through a group of magnets or to pump on the helium bath to reduce temperature in the system. One small circulating compressor tested employs tilting-pad gas bearings and is driven by a DC motor. The two small cold vacuum pumps tested use oil bearings and are driven by oil turbines. The three large oil-bearing cold compressors are driven by DC motors through a gear box. A unique feature of the large vacuum pump is the combination of two pumps with a total of four stages on the same shaft. The adiabatic efficiencies are found to be 57% for the large vacuum pumps and close to 50% for the large circulating compressor. Good overall reliability has been experienced. DOE

**N88-10983#** Sandia National Labs., Albuquerque, N. Mex.
**EFFECTS OF BARREL JOINTS ON HYPERVELOCITY PROJECTILES**
M. Shahinpoor, J. R. Asay, W. R. Dixon, and R. S. Hawke 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987 Prepared in cooperation with New Mexico Univ., Albuquerque and Lawrence Livermore National Lab., Calif.
(Contract DE-AC04-76DP-00789)
(DE87-013447; SAND-87-1006C; CONF-870753-52) Avail: NTIS HC A02/MF A01

Development of new hypervelocity launchers is necessary for equation of state (EOS) studies at high impact velocities. The requirements for barrel joint alignment and concentricity at high velocities place severe constraints on fabrication and assembly procedures; small steps or longitudinal direction changes at joints may cause major damage to precision projectiles. Research has been initiated to identify the technical limits of fabrication and assembly tolerances for hypervelocity gun barrels. Numerical and experimental studies have evaluated projectile performance at velocities of 6 to 15 km/s and have identified failure modes for Lexan projectiles with thin metal facings. DOE

**N88-10984#** Los Alamos National Lab., N. Mex.
**COMPUTER MODELING OF METAL FORMING**
D. A. Korzekwa, F. M. Guerra, P. S. Follansbee, and M. G. Stout Sep. 1987 85 p
(Contract W-7405-eng-36)
(DE87-013804; LA-10920-MS) Avail: NTIS HC A05/MF A01

A program to develop the capability to model metal forming operations is in progress. Two forming operations were chosen as model problems for evaluating the accuracy of existing codes and determining their applicability for these types of problems. Detailed inspection of the parts produced by these operations supplied experimental results for comparison with the model. The material chosen for study, 304L stainless steel, was characterized to provide material properties for the study. The operations were modeled with two different finite element codes - ADINA78 and NIKE2D. The results indicate that forming operations where friction is not important can be modeled with reasonable accuracy for isotropic materials. The results for a thin sheet problem indicate that when friction is a dominant factor the existing codes have deficiencies that can cause large errors. In the course of this investigation a new friction model that seems to offer some improvement was implemented in both codes. DOE

**N88-10985#** Joint Publications Research Service, Arlington, Va.
**USSR REPORT: ENGINEERING AND EQUIPMENT**
4 May 1987 133 p Transl. into ENGLISH from various Russian articles
(JPRS-UEQ-87-007) Copyright Avail: NTIS HC A07/MF A01

Translated articles from various Russian periodicals on Engineering and equipment are presented. The areas of emphasis are: Aeronautical and Space; Surface Transportation; Nuclear Engineering; Industrial Technology; Turbine and Engine Design; Navigation and Guidance Systems; and High Energy Devices, Optics and Photography; and Fluid Mechanics; and Mechanics of Solids; and Testing and Materials. Sample titles are: Ensuring the service life of design; Ultrasonic mechanized checking of weld joints of nuclear power plant equipment; Improving repairability of gears; and Vibration-absorbing characteristics of metal polymer shells. For individual titles, see N88-10986 through N88-11001.

**N88-10986#** Joint Publications Research Service, Arlington, Va.
**ENSURING THE SERVICE LIFE OF DESIGNS (EXPERIENCE IN AIRCRAFT CONSTRUCTION)** c01
A. F Selikhov and Zhukovskiy *In its* USSR Report: Engineering

and Equipment 4 May 1987 p 1-11 Transl. into ENGLISH from Mashinovedeniye (Moscow, USSR), no. 5, Sep.-Oct. 1986 p 11-18 (For primary document see N88-10985 02-31)
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The high cost of an aircraft makes it necessary to operate it for 20 to 25 years with ever increasing intensity. Increasing requirements on weight improvement, a significant level of variable loads, long service life and large number of functional and loading cycles results in the fact that the service life of the main load bearing structure of an aircraft is limited, i.e., the design may exhaust its load carrying capacity prematurely. The most frequently encountered and most hazardous due to unexpected causes of possible cessation of operation is structural fatigue due to exhaustion of its load carrying capacity and initial production defects and also damage caused by corrosion and wear. Criteria are enumerated which place limitations on providing the required service life of the design with minimum expenditures of mass. The typical distribution of service life of a design before the first damage in operation is shown. The measures which must be implemented during the very beginning of design, during manufacture of the aircraft and reliability before beginning of design are briefly discussed. E.R.

**N88-10987#** Joint Publications Research Service, Arlington, Va.
**ULTRASONIC MECHANIZED CHECKING OF WELD JOINTS OF NUCLEAR POWER PLANT EQUIPMENT c38**
V. M. Lantukh and M. Z. Tayts *In its* USSR Report: Engineering and Equipment 4 May 1987 p 21-24 Transl. into ENGLISH from Energetik (Moscow, USSR), no. 7, Jul. 1986 p 20-21 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

The ultrasonic checking method is used to detect nonpenetration joints in the equipment metal during installation and operation of nuclear power plants. Investigations directed toward solution of the problems, related to automation and mechanization of the ultrasonic method of checking metal during operation of the equipment of nuclear power plants, have been conducted for many years. Original automated systems for ultrasonic checking were developed to solve problems at the level of experimental models. The development of these automated checking machines is briefly discussed. E.R.

**N88-10988#** Joint Publications Research Service, Arlington, Va.
**HUMAN FACTORS IN ROBOTIC SYSTEM DESIGN DISCUSSED c54**
V. N. Prokofyev and T. A. Chernysheva *In its* USSR Report: Engineering and Equipment 4 May 1987 p 53-56 Transl. into ENGLISH from Izvestiya Vysshykh Uchebnykh Zavedeniy: Mashinostroyeniye (Moscow, USSR), no. 8, Aug. 1986 p 76-78 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

A principle underlying the investigation of a manipulation robot with hydraulic drive remotely controlled in a semiautomatic mode is discussed. Experimental data is presented on the operation of the hydraulic drive of the manipulator obtained by the frozen coefficient method. Parameters are obtained at which the system is stable. Results are presented of an investigation of the man operated hydraulic drive system with tracking (accomplishing the operation of gripping a floating object) at a frequency of 0.1 Hz. Author

**N88-10989#** Joint Publications Research Service, Arlington, Va.
**IMPROVING REPAIRABILITY OF GEARS c37**
S. A. Belyayev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 57-59 Transl. into ENGLISH from Mashinostroitel (Moscow, USSR), no. 5, May 1986 p 34 (For primary document see N88-10985 02-31)
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Increased service life and decreased vibrational activity of gear transmissions can be achieved by using composite gears with self-aligning ring gears. In such gears, power interaction between the ring gear and the hub is accomplished via elastic joints. In repairing such gears, the most acceptable solution is to replace a worn ring gear with a new one, while reusing the hub over again. In order to improve repairability of composite gears an intermediate ring is placed between the ring gear and the hub. The design of such gears is shown and how it improves repairability is discussed. E.R.

**N88-10990#** Joint Publications Research Service, Arlington, Va.
**PROCEEDINGS OF CONFERENCE ON VIBRODIAGNOSTICS DISCUSSED c39**
*In its* USSR Report: Engineering and Equipment 4 May 1987 p 67-69 Transl. into ENGLISH from Mashinovedeniye (Moscow, USSR), no. 4, Jul. - Aug. 1986 p 103-104 Presented at the 1st All-Union Conference on Problems in Vibroacoustic Diagnostica for Machines and Equipment, Ivanova (USSR), 9-11 Sep. 1985 (For primary document see N88-10985 02-31)
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Vibroacoustic diagnosis for machines and equipment is one of the most important areas in the field of mechanical diagnostics. Machines in operation generate vibroacoustic signals, the parameters of which contain information defining the operation condition of the piece machinery involved. The conference worked in two sections: Vibrodiagnostics for machines and mechanical systems, and Vibrodiagnostics for structures and structural components. The conference proved an occasion for an exceptionally productive exchange of experience in the theoretical study and development and the introduction and practical application of vibroacoustic diagnostic systems and equipment. Papers and discussions presented drew attention to some serious shortcomings in the field of hydroacoustic diagnostics, situations which are placing obstacles in the way of extensive introduction of these systems into practical use. Among the most critical problems are the limited volume of vibration measuring and analyzing apparatus made and the failure to provide training in the field. Author

**N88-10991#** Joint Publications Research Service, Arlington, Va.
**VIBRATION-ABSORBING CHARACTERISTICS OF METAL-POLYMER SHELLS Abstract Only c39**
V. M. Chernyshev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 79 Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy: Machinostroyeniye (Moscow, USSR), no. 8, Aug. 1986 p 38-43 (For primary document see N88-10985 02-31)
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The vibration absorbing characteristics of metal shells with elastic polymer damper coatings are calculated by the energy method on the basis of Kirchoff-Love hypotheses. All layers of the multilayer coating are assumed to cooperate so that all strain components are continuous functions of the space coordinates, assuming also a plane state of stress. The resonance modes of coated shells are the same as the natural modes of homogeneous shells without inelastic damping, in accordance with Wiedler's rule. The amplitude dependence of the absorption coefficient obtained for circular cylindrical steel shells coated with polymer materials such as iridescent or VML-25 grade is compared with experimental data. A shell reinforced with heavy rings at the upper end was vertically hanging on two strings between 2 a.c. electromagnets, to satisfy Navier boundary conditions. The experimental equipment included a low frequency signal generator with preamplifier and power amplifier, a set of resistance strain gages, a frequency meter with two inputs, a microvoltmeter, and a light beam oscillograph. Agreement is close, the results indicating suppression of almost the entire vibration spectrum but most effectively the flexural higher-order modes. Author

**N88-10992#** Joint Publications Research Service, Arlington, Va.
**TURBINES WITH COUNTERROTATING RUNNERS FOR AIRCRAFT POWER PLANTS Abstract Only c07**
B. A. Ponomarev and Yu. V. Stosenko *In its* USSR Report: Engineering and Equipment 4 May 1987 p 93 Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy: Aviationnaya Tekhnika (Kazan, USSR), no. 2, Apr. - Jun. 1986 p 50-53 Original language document was announced in IAA as

A87-15211 (For primary document see N88-10985 02-31)
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A classification of turbines with counter rotating rotors is presented, and their classifications in aircraft power plants of various types are examined. The principal gasdynamic characteristics of the traditional (fixed stator) and nontraditional (birotational) turbine designs are discussed. For birotational turbines, characteristic kinematic relationships are obtained, and an expression is proposed for determining the gasdynamic loading parameter. E.R.

**N88-10993#** Joint Publications Research Service, Arlington, Va.
**DIAGNOSIS OF FLOW CHANNEL IN AIRCRAFT GAS-TURBINE ENGINES ON BASIS OF VIBRATION SPECTRUM CHARACTERISTICS Abstract Only** **c07**
A. G. Mironov and S. M. Doroshko *In its* USSR Report: Engineering and Equipment 4 May 1987 p 93 Transl. into ENGLISH from Izvestiya Vysshikh Uchebsnykh Zavedeniy: Aviatsionnaya Tekhnika (Kazan, USSR), no. 2, Apr. - Jun. 1986 p 45-49 Original language document was announced in IAA as A87-15210 (For primary document see N88-10985 02-31)
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An improved vibration spectrum model is presented which allows for the presence of combination components. Methods are then examined for evaluating the aerodynamic inhomogeneity of a rotor of a dual shaft gas turbine engine from the vibration parameters based on the combination components. The accuracy of the results is confirmed experimentally. E.R.

**N88-10994#** Joint Publications Research Service, Arlington, Va.
**EQUAL-MODULUS VECTOR PROGRAMMED FREQUENCY CONTROL OF MINIMALLY REDUNDANT STRUCTURE OF POWERED, SINGLE-DEGREE-OF-FREEDOM GYROSCOPES FOR SPACECRAFT ATTITUDE CONTROL SYSTEM Abstract Only** **c18**
Yu. A. Karpachev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 94 Transl. into ENGLISH from Mekhanika Tverdogo Tela (Moscow, USSR), no. 2, Feb. 1986 p 3-10 (For primary document see N88-10985 02-31)
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Powered gyroscopic spacecraft attitude control is based on the changing of the total kinetic moment vector of the gyroscopic system (H vector) along spacecraft axes. With a known mechanical model of the spacecraft and a given or real-time synthesized attitude control program, the control of the powered gyroscopes reduces to the determination of the angular precession rates of the gyros needed to effect a programmed change in the H vector, and determination of the pulse repetition rate of the precession axis step motor drives which will produce the desired change in precession frequency. A theoretical analysis is presented of such programmed frequency control for a minimally redundant, coplanar gyroscopic system, in which the gyroscopes are distributed in two nonorthogonal powered gyroscope groups. The precession axes of each of these groups are parallel to each other. The basis of the gyro system control is the breaking down by the vector sum of the kinematic moments of the 2 gyroscopes with the gyroscopic suspension axes parallel to each other. The presence of these two equal modulus vectors maximizes the gyroscopic system control range, minimizes the number of singular states and enables the construction of algorithms. Author

**N88-10995#** Joint Publications Research Service, Arlington, Va.
**CALIBRATION OF ATTITUDE CONTROL SENSORS Abstract Only** **c19**
Ye. M. Potapenko *In* ita USSR Report: Engineering and Equipment 4 May 1987 p 95 Transl. into ENGLISH from Mekhanika Tverdogo Tela (Moscow, USSR), no. 2, Feb. 1986 p 11-17 Original language document was announced in IAA as A86-41427 (For primary document see N88-10985 02-31)
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The principles governing the development of simple algorithms for calibrating attitude and velocity sensors without the need for reference point identification and without using information on the orientation of the moving object are examined. The approach proposed here makes it possible to calibrate attitude and velocity sensors by using an onboard computer. E.R.

**N88-10996#** Joint Publications Research Service, Arlington, Va.
**FOCUSING SOLAR ENERGY COLLECTOR** **c44**
I. V. Baum and A. K. Nalitkin *In its* USSR Report: Engineering and Equipment 4 May 1987 p 97-101 Transl. into ENGLISH from Izvestiya Akademii Nauk Turkmenskoy SSR: Seriya Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk (Ashkhabad, USSR), no. 1, Jan. - Feb. 1986 p 28-31 (For primary document see N88-10985 02-31)
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The thermal losses in solar collectors are controlled by different methods. A considerable part of the thermal losses in the collectors is through the glass coating (the top cover). The use of concentrating mirror elements permits an increase of the efficiency of solar collectors by increasing the energy density on the surface of the heat collector and by reducing its area. The total heat losses of the collector are reduced, the temperature on the heat exchange surface is increased and the efficiency of conversion of solar energy to thermal energy is increased. The focusing collector with concentrating elements was developed and tested. The development and testing of these focusing elements are discussed. E.R.

**N88-10997#** Joint Publications Research Service, Arlington, Va.
**INSTABILITY OF STEADY FLOW WITH CONSTANT VORTICITY IN VESSELS WITH ELLIPTICAL CROSS-SECTION Abstract Only** **c34**
V. A. Vladimirov and D. G. Vostretsov *In its* USSR Report: Engineering and Equipment 4 May 1987 p 105 Transl. into ENGLISH from Prikladnaya Matematika i Mekhanika (Moscow, USSR), v. 50, no. 3, Mar. 1986 p 369-377 Original language document was announced in IAA as A87-10428 (For primary document see N88-10985 02-31)
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The problem of the stability flows of an ideal incompressible fluid in vessels of elliptical cross section is analyzed for the case where the main flow velocity field is a linear function of the coordinates and the vorticity is constant. The spectral problem for linear perturbations is solved by the method of successive approximations. The instability of the flows is demonstrated to a first approximation. The particular case of flow in a triaxial ellipsoid is examined in detail. The flow stability problem examined is relevant to the study of the properties of fluid filled gyroscopes and of the behavior of the nuclei of stars and planets. E.R.

**N88-10998#** Joint Publications Research Service, Arlington, Va.
**EFFECT OF DISSIPATION ON PROPAGATION OF SPHERICAL DETONATION SHOCK WAVE Abstract Only** **c34**
V. N. Likhachev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 106 Transl. into ENGLISH from Prikladnaya Matematika i Mekhanika (Moscow, USSR), v. 50, no. 3, Mar. 1986 p 384-393 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

The system of equations describing spherical wave motion of a viscous compressible fluid through a weakly compressible medium is combined with the equation of piston motion simulating the effect of detonation products. The complete boundary value problem is solved by the method of asymptotic expansions in a small parameter. A solution is obtained for early dimensionless time and for late dimensionless time, then for the intermediate period by collocation of asymptotes. On this basis are then calculated the dynamic characteristics of flow along the piston and are plotted shock wave profiles depending on the Reynolds number, unlike those of shock waves of an inviscid fluid. These profiles are found to be parabolic, while those in the zone of a plain wave are hyperbolic. Author

**N88-10999#** Joint Publications Research Service, Arlington, Va.
**REFRACTION OF SHEAR WAVE INTO NONLINEARLY ELASTIC OR ELASTOPLASTIC HALF-SPACE Abstract Only** **c34**

A. G. Bykovtsev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 106 Transl. into ENGLISH from Prikladnaya Matematica i Mekhanika (Moscow, USSR), v. 50, no. 3, Mar. 1986 p 490-497 (For primary document see N88-10985 02-31)
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The problem of dynamics in the theory of complex shear is solved for refraction of shear waves into a nonlineary elastic or, in the extreme case, an elastoplastic medium. The equations of motion with antiplane deformation and the condition of compatibility are formulated in a Cartesian system of coordinates where all displacement and velocity are oriented along the x sub 3 axis and are functions of x sub 1, x sub 2 coordinates and time only, while all components of the stress tensor are zero except its shear components. The parameters of this system of equations are assumed to satisfy the condition which makes it a hyperbolic one. The solution is compared with the author's solution to the problem of refraction of planary polarized plane shear waves at the boundary of an elastic or elastoplastic half space, that problem having been solved with the aid of Prandtl-Reuss equations.
Author

**N88-11000#** Joint Publications Research Service, Arlington, Va.
**NONSTEADY-STATE VIBRATIONS IN ACOUSTIC MEDIUM OF ELASTIC ELLIPTICAL SHELL SUBJECTED TO INSTANTANEOUSLY APPLIED UNIFORM PRESSURE Abstract Only** c39
V. V. Karpenko, A. S. Pankratov, and V. I. Saygina *In its* USSR Report: Engineering and Equipment 4 May 1987 p 113 Transl. into ENGLISH from Mekhanika Tverdogo Tela (Moscow, USSR), no. 2, Feb. 1986 p 173-179 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

An external pressure is instantaneously applied to a thin, elastic, structurally orthotropic shell, the center surface of which forms an elliptical cylinder. The nature of the load and the structural geometry make it possible to treat the motion of the shell as a planar shell using thin shell theory. The influence of the ratio of the minor to the major axes on the nature of the vibrations of such a shell is examined. Cumbersome analytical expressions are derived and solved numerically in order to illustrate the normal deflection of the cylinder for minor to major axis ratios of between 0.5 to 1.0. The process of the deformation of circular and elliptical rings loaded by the same external pressure is shown to be qualitatively different and is depicted graphically. The influence of a frame-type reinforcement for an elliptical shell on the rate of change in the deformation for a minor to major axis ratio of 0.90 is also shown graphically. The influence of the stiffening frame on the overall stresses at the internal boundary of an elliptical ring due to compression and bending is also graphed. The equations can be extrapolated to an arbitrary load by means of a Duhamel integral.
Author

**N88-11001#** Joint Publications Research Service, Arlington, Va.
**NEED FOR COMPOSITES, NEW MATERIALS DISCUSSED** c24
N. Zhavoronkov, I. Fridlyander, and R. Shalin *In its* USSR Report: Engineering and Equipment 4 May 1987 p 115- 117 Transl. into ENGLISH from Izvestiya (Moscow, USSR), 1 Sep. 1986 p 2 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

There is a demand today for increasingly strong and lightweight construction materials. The theoretical strength of crystalline materials appear to far outweigh those of steel and aluminum alloys. However, there is a vast difference between the theoretical and practical strength of these materials due to microstructure defects or crystal lattice defects called dislocations. Technology has been able to create high strength fibers with a relatively low density. For example, there has been a rapid growth in research in the area of silicon carbide fibers. The route this research is taking and its applications to construction materials are discussed.
E.R.

**N88-11002#** Hoechst CeramTec A.G., Selb (West Germany).
**DEVELOPMENT OF A STATISTICALLY PROVEN INJECTION MOLDING METHOD FOR REACTION BONDED SILICON NITRIDE, SINTERING REACTION BONDED SILICON NITRIDE, AND SINTERED SILICON NITRIDE Final Report, 1 Jul. 1985 - 30 Jun. 1986**
Matthias Steiner 1987 49 p In GERMAN; ENGLISH summary Sponsored by the Bundesministerium fuer Forschung und Technologie, Federal Rep. of Germany
(ETN-87-90575) Avail: NTIS HC A03/MF A01

A statistically proven, series injection molding technique for ceramic components was developed for the construction of engines and gas turbines. The flow behavior of silicon injection-molding materials was characterized and improved. Hot-isostatic-pressing reaction bonded silicon nitride (HIPRBSN) was developed. A nondestructive component evaluation method was developed. An injection molding line for HIPRBSN engine components precombustion chamber, flame spreader, and valve guide was developed. This line allows the production of small series for engine tests.
ESA

**N88-11003#** Rolls-Royce Ltd., Derby (England).
**INVESTMENT FOUNDRY MELTING STOCK. ROLLS ROYCE REQUIREMENTS AND DEMANDS IN TERMS OF QUALITY AND THE RELATIONSHIP TO END PRODUCT PERFORMANCE**
A. K. Gibbons 28 Apr. 1987 5 p Submitted for publication
(PNR90397; ETN-87-91000) Copyright Avail: NTIS HC A02/MF A01

Requirements and controls in terms of melt stock production procedures, quality, and acceptance for gas turbine investment castings are discussed. The influence of melt stock quality on the castings produced is reviewed.
ESA

# 32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

**N88-11004** Pennsylvania Univ., Philadelphia.
**NONLINEAR TECHNIQUES FOR DETECTION AND FILTERING OF DISCRETE-TIME SIGNALS Ph.D. Thesis**
Iickho Song 1987 321 p
Avail: Univ. Microfilms Order No. DA8714135

New schemes for signal detection and filtering which have a basis in statistical theory were investigated. A generalized observation model for signal detection problems is proposed. The model includes several interesting and common special cases such as those describing additive noise, multiplicative noise, and signal-dependent noise. Locally optimum detectors for known signals and those for random signals in the proposed model are derived and analyzed for performance. The locally optimum detectors are interesting generalizations of those for the additive noise model and their performance is compared to that of other common detectors. Nonlinear filters that have a basis in the class of rank-estimates (R-estimates) from statistical theory are investigated. Having a basis in the R-estimates which are known to be robust, the filters have such desirable characteristics as edge preservation, detail retention,and impulse rejection, as well as the property of Gaussian noise smoothing. Performance characteristics of the limited-degree extended-averaging Wilcoxon (LEW) filters are analyzed and their action simulated on 1- and 2-dimensional signals. The filters considered here together with recent results on L- and M-filters show that all three well-known classes of robust location estimates, the L-, M-, and R-estimates, can be applied to nonlinear smoothing of signals. Dissert. Abstr.

**N88-11005** California Univ., Los Angeles.
**IONOSPHERIC TOTAL ELECTRON CONTENT ESTIMATION FOR SINGLE-FREQUENCY GLOBAL POSITIONING SYSTEM RECEIVERS Ph.D. Thesis**
Carey A. Smith 1987 124 p
Avail: Univ. Microfilms Order No. DA8713861

The ionosphere delays transmissions from the Global Positioning System (GPS) as well as those from other satellite systems. At the GPS frequencies (L-Band), this delay is directly proportional to the total ionospheric electron content (TEC) along the line-of-sight to the satellite. Classified receivers have access to 2 frequencies, to allow them to measure this delay through the difference in the ionospheric effect at the 2 frequencies, but commercial, single-frequency receivers had no direct method for estimating the ionospheric delay; thay have had to rely on a TEC prediction. Two methods are described for single-frequency GPS receivers to estimate the ionospheric TEC directly. These methods take advantage of the dispersive nature of the ionosphere at L-Band frequencies, which causes a phase advance of the carrier that is opposite to the group delay of the GPS code and data.
Dissert. Abstr.

**N88-11006#** National Telecommunications and Information Administration, Boulder, Colo. Inst. for Telecommunication Sciences.
**GAIN EVALUATION FOR AN IDEALIZED CURTAIN ARRAY ANTENNA**
N. A. Kuester May 1987 33 p Sponsored by Voice of America, Washington, D.C.
(PB87-210290; NTIA-87-215) Avail: NTIS HC A03/MF A01 CSCL 20N

An expression for the gain of a curtain array antenna over a perfectly conducting, flat Earth with no mutual impedance between elements is derived in the report. A FORTRAN computer subroutine created to calculate the expression is described here. The subroutine considers interelement spacing and length of the individual elements, the spacing between the radiators and the reflecting screen behind the radiators, the antenna design and operating frequencies, and the number of elements in the array.
GRA

**N88-11007#** New Mexico Univ., Albuquerque.
**ON ADAPTIVE SIGNAL PROCESSING OF RF SIGNALS**
N. Ahmed, B. Armstrong, C. Rogers, and G. R. Elliott Jun. 1987 16 p Presented at the International Symposium on the Mathematics of Networks and Systems, Phoenix, Ariz., 18 Jun. 1987 Prepared in cooperation with Sandia National Labs., Albuquerque, N. Mex.
(Contract DE-AC04-76DP-00789)
(DE87-014192; SAND-87-1494C; CONF-8706189-1) Avail: NTIS HC A03/MF A01

This paper addresses the problem of extracting a chirp-like signal from noise which is in the form of narrowband rf interference. An adaptive prediction approach is proposed. Computer simulation results and some hardware aspects are also included. DOE

**N88-11008#** American Univ., Washington, D. C.
**EXPERIMENTAL STUDIES OF ELECTROMAGNETIC PROPERTIES OF FEW BODY SYSTEMS**
P. E. Bosted Aug. 1987 8 p Presented at the CEBAF Summer Workshop, Newport News, Va., 22-26 Jun. 1987 Prepared in cooperation with SLAC, Menlo Park, Calif.
(Contract DE-AC03-76SF-00515; Grant NSF PHY-85-10549)
(DE87-014610; SLAC-PUB-4386; CONF-8706200-1) Avail: NTIS HC A02

An overview is given of some recent and planned experiments which have or will substantially increase our knowledge of the electromagnetic properties of few body systems. Specific examples include the proton and neutron elastic form factors, the deuteron elastic form factors, deuteron threshold electrodisintegration and quasi-elastic scattering, deuteron photodisintegration, and finally measurements of cross sections in deep inelastic scattering from hydrogen, deuterium, and iron. DOE

**N88-11009** British Broadcasting Corp., Kingswood (England). Engineering Div.
**A REVIEW OF THE SEMICONDUCTOR STORAGE OF TELEVISION SIGNALS. PART 2: APPLICATIONS 1975-1986**
J. L. Riley Aug. 1987 33 p
(BBC-RD-1987/6) Avail: Issuing Activity

This is the second of two reports. In the first, the emerging semiconductor memory technology over the last two decades and some of the important operational characteristics of each ensuing generation of device are described together with the design philosophy for forming the devices into useful tools for the storage of television signals. The second of these reports describes some of the applications. These include improved television synchronizers, high quality PAL decoders, television noise reducers, film dirt concealment equipment and buffer storage for television picture processing equipment such as stills stores. The continuing developments in the technology promise still further increases of memory capacity and there is a proposal to build a mass semiconductor television picture sequence store, initially as a research tool. Author

**N88-11010** British Broadcasting Corp., Kingswood (England). Engineering Div.
**A DIGITAL AUDIO LINK TO THE CHANNEL ISLANDS IN THE UHF TELEVISION BAND: PROTECTION OF TELEVISION SIGNALS FROM DIGITALLY MODULATED INTERFERENCE**
J. H. Stott and P. R. Durrant Jul. 1987 16 p
(BBC-RD-1987/7) Avail: Issuing Activity

Proposals were made to use a digitally modulated signal in a UHF television channel to feed radio program sound to the Channel Islands. It is clearly necessary to demonstrate that the proposed link will not cause unacceptable interference to existing UHF television services, including those of France. However, calculations concerning the problem were hindered because the protection radio needed when an interferer is digitally modulated was not known; in contrast, values for continuous wave (CW) or television interferers are provided by the CCIR and are well established. Subjective tests were therefore conducted to establish the protection ratios for SECAM and PAL television signals suffering interference of the type produced by the proposed digital link. The results confirmed that the energy dispersal provided by digital modulation of an interfering signal reduces the visibility of worst case interference so that the protection ratio can be relaxed accordingly, by an amount ranging from 3 to 12 dB for SECAM and 2 to 10 dB for PAL. If precision offset of the carrier is used the visibility of CW interference is greatly reduced whereas the visibility of digitally modulated interference is unchanged; the protection ratio for digitally modulated interference is therefore the same with and without precision offset. Author

**N88-11011** British Broadcasting Corp., Kingswood (England). Engineering Div.
**A DIGITAL AUDIO LINK TO THE CHANNEL ISLANDS IN THE UHF TELEVISION BAND: PRELIMINARY EXPERIMENTAL RESULTS**
M. C. D. Maddocks Sep. 1987 9 p
(BBC-RD-1987/9) Avail: Issuing Activity

A digital audio link in the UHF television band has been proposed as a means of feeding radio programs over the long sea path to the Channel Islands. An experimental link has been installed to test the viability of such a proposal. Results from the first five months are presented. Author

**N88-11012** British Broadcasting Corp., Kingswood (England). Engineering Div.
**THE CRITERION OF EQUAL INTEGRATED QUALITY: AN IMPROVED METHOD OF PLANNING DBS SYSTEMS**
P. Shelswell and J. H. Stott Sep. 1987 21 p
(BBC-RD-1987/10) Avail: Issuing Activity

A new technique for use in international planning of satellite broadcasting is proposed. The planning procedure would use this technique to provide an equal weighted mean quality for all circuits, as opposed to conventional techniques which would equalize the

minimum quality (usually that exceeded for all but a given small percentage of the time). As a consequence, there is a different tradeoff between the necessary transmit power on board the satellite and the outage time. This compromise leads to more equitable access to spectrum especially for areas where rain attenuation is high. Author

**N88-11013#** Department of Communications, Ottawa (Ontario). Communications Research Centre.
**THEORY AND METHODS FOR DESIGN OF PULSE SHAPES FOR BROADCAST TELETEXT**
M. Sablatash, J. H. Lodge, and K. W. Moreland Oct. 1986 58 p
(CRC-1405) Avail: NTIS HC A04/MF A01

This report describes the theoretical and practical engineering constraints, considerations and methods for pulse shape design for North American broadcast teletext transmissions, and describes the design and performance of new overall (i.e., end-to-end) and transmitted pulse shapes. The principles and ideas described are for broadcast over-the-air transmission but they are also applicable to satellite and cable transmission of broadcast teletext signals. The broadcast teletext model is described. Basic constraints and considerations from the Nyquist theory and its extensions are given. The practical and engineering constraints on teletext pulse shapes are discussed in detail. A review is provided of the theory and design methods for teletext pulse shaping, including analytical approaches which do not appear to have been applied to this problem previously, and numerical approaches. Modelling and simulation approaches are described, including a new, comprehensive simulation program. The design of improved overall and transmitted pulse shapes is described, and their performance evaluated and compared to that obtained with the other common pulse shapes. Author

**N88-11014#** MATRA Espace, Toulouse (France).
**DATA RELAY SATELLITE ANTENNA SUBSYSTEM STUDY Final Report**
B. LeStradic, comp. Paris, France ESA 9 Dec. 1986 341 p
(Contract ESTEC-6664/86-NL-PR)
(ESA-CR(P)-2435-Vol-2; ETN-87-90891) Avail: NTIS HC A15/MF A01

An antenna for a Data Relay Satellite linking four independent user satellites on low Earth orbits is proposed. Two users require accesses at Ka band, around 25 GHz, for high data rates, and the other two are at S Band, around 2 GHz, for medium and low data rates. An antenna diameter in the range of 260 cm is needed for each user. The preferred configuration is with separate S and Ka antennas. At S Band, it is recommended to use a single active array (dual access, Rx/Tx), and mass saving has to be achieved to make this solution even more attractive. At Ka band, two reflector antennas are foreseen: the feed system is fixed on the spacecraft and the scanning is obtained through a movement of the main reflector around the center of gravity, which reduces the impact of the attitude/orbit control system. ESA

**N88-11015#** Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Systemes et Communications.
**STUDY OF A CODING AND MODULATION SYSTEM FOR THE V32 CALL OF THE CCITT Ph.D. Thesis [ETUDE DU SYSTEME DE MODULATION ET DE CODAGE DE L'AVIS V32 DU CCITT]**
Maamar Mekraoui Apr. 1987 192 p In FRENCH
(ENST-87E007; ISSN-0751-1353; ETN-87-90910) Avail: NTIS HC A09/MF A01

The optimization of decoders of digital links is discussed. It is shown that development with the Viterbi algorithm must be based on computerized simulation. Tests indicate that the ratio of coded to uncoded system gain is the same in simulation or experiments. The improvement of modulation performance by shift of the quadrature amplitude is also studied. The coding and modulation techniques studied allow a gain of 4 dB over the uncoded transmission. This may be of interest for the development of high rate transmission (9600 bits/sec) in telephone communication. ESA

**N88-11016#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**MODELING AND PERFORMANCE EVALUATION OF THE DPS25 PACKET SWITCHING MULTIPROCESSOR SYSTEM Ph.D. Thesis [MODELISATION ET EVALUATION DES PERFORMANCES DU SYSTEME MULTIPROCESSEUR DE COMMUTATION DES PAQUETS DPS25]**
Spyridon Mitropoulos May 1987 219 p In FRENCH
(ENST-87E009; ISSN-0751-1353; ETN-87-90911) Avail: NTIS HC A10/MF A01

A packet switching communication network is evaluated via queue network modeling theory. Direct access memory systems, busses linking the network processors, commutation and signal processors, and virtual reference circuits are considered. All models are developed with the help of the QNAP2 program and listings of the models are given. The method is illustrated with results from simulations at the various system levels. ESA

**N88-11017#** Toulouse Univ. (France). Lab. d'Automatique et d'Analyse des Systemes.
**CONTRIBUTION TO THE STUDY OF CIRCUIT SWITCHED NETWORKS: MODELING AND NUMERICAL SOLUTIONS Ph.D. Thesis - Paul Sabatier Univ.**
Francoise LeGall 1987 134 p In FRENCH; ENGLISH summary
(LAAS-87-174; ETN-87-90912) Avail: NTIS HC A07/MF A01

Models for circuit switched network performance evaluation were derived. One is a Markovian model: circuit switched networks can be represented by a quasi birth-death process. The Markovian system is generated in order to obtain a block-tridiagonal transition matrix. Point iterative methods and an aggregation-disaggregation method are proposed. Another is a one moment model developed for performance evaluation and optimization. Fictitious offered traffics are introduced to take into account the peaky or smooth nature of the traffics. The advantages of this second model are shown. ESA

**N88-11018#** Alcatel Thomson Espace, Toulouse (France).
**STUDY OF ANTENNA CONFIGURATION FOR DATA RELAY SATELLITE (DRS) USER SPACECRAFT Final Report**
Paris, France ESA Dec. 1986 213 p
(Contract ESA-6516/85-NL-PB)
(A5/516/86; ESA-CR(P)-2421; ETN-87-90918) Avail: NTIS HC A10/MF A01

Wide scanning angle antenna systems for use from LEO user satellites to GEO data relay satellites were studied. Compactness and lightweight design are emphasized. The case of users with medium data acquisition rates is considered: a capacity of 10 Mbit/sec is required, which implies high gain antennas. Frequencies in the Ka band should permit the design of such compact high gain antennas. Mechanically scanned antennas, mechanically/electronically scanned antenna systems, and fully electronically scanned antenna systems meet objectives. ESA

**N88-11019#** MATRA Espace, Toulouse (France).
**DRS (DATA RELAY SATELLITE) ANTENNA SUBSYSTEM STUDY Final Report**
Paris, France ESA 9 Dec. 1986 191 p
(Contract ESTEC-6664/86-NL-PR)
(ESA-CR(P)-2435-Vol-1; ANT/NTEA/027-86; ETN-87-90921)
Avail: NTIS HC A09/MF A01

An antenna for a data relay satellite linking four independent user satellites on low Earth orbits is proposed. Two users require accesses at Ka band, around 25 GHz, for high data rates, and the other two are at S Band, around 2 GHz, for medium and low data rates. An antenna diameter in the range of 260 cm is needed for each user. The preferred configuration is with separate S and Ka antennas. At S Band, it is recommended to use a single active array (dual access, Rx/Tx), and mass saving has to be achieved to make this solution even more attractive. At Ka Band, two reflector

antennas are foreseen: the feed system is fixed on the spacecraft and the scanning is obtained through a movement of the main reflector around the center of gravity, which reduces the impact on the attitude/orbit control system. ESA

**N88-11020#** Loughborough Univ. of Technology (England). Dept. of Electrical and Electronic Engineering.
**AIRBORNE BISTATIC RADAR APPLICATIONS M.S. Thesis**
James A. Foster 1987 171 p
(ETN-87-90930) Avail: NTIS HC A08/MF A01

Applications of bistatic radar when one or both of the units are airborne are discussed. Scenarios that merit deeper consideration are covert strike and head-on SAR using a stand-off illuminator, either airborne or space-based; area air defense with passive ground-based receivers and stand-off illuminators; an airborne picket line to detect stealth aircraft and missiles; AWACS aircraft providing mutual support in ECM environments; and passive surveillance of hostile air space using illuminators of opportunity and an airborne receiver. Scenarios considered impractical are bistatic air-to-air missile guidance using an aircraft other than the launch aircraft as illuminator; passive interdiction using illuminators of opportunity; and scenarios involving a ground based illuminator and an aircraft as the receiver. ESA

# 33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

**N88-11021*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**THE 1986 GODDARD SPACE FLIGHT CENTER BATTERY WORKSHOP**
George W. Morrow, ed. and Thomas Y. Yi, ed. Sep. 1987 374 p Workshop held in Greenbelt, Md., 18-19 Nov. 1986
(NASA-CP-2486; Rept-87B0408; NAS 1.55:2486) Avail: NTIS HC A16/MF A01 CSCL 10C

The subjects covered include: lithium cell technology and safety improvements; nickel-cadmium separator and electrode technology along with associated modifications; flight experience and life testing of nickel-cadmium cell; and nickel-hydrogen applications and technology. For individual titles, see N88-11022 through N88-11040.

**N88-11022*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**COMPUTER SIMULATION OF THERMAL MODELING OF PRIMARY LITHIUM CELLS**
I. Cho Young (Drexel Univ., Philadelphia, Pa.), Harvey Frank, and Gersid Halpert *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 21-60 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The objective was to gain a better understanding of the safety problem of primary Li-SOCl2 and Li-SO2 cells by carrying out detailed thermal modeling work. In particular, the transient heat generation rates during moderate and extermely high discharge rate tests of Li-SOCl2 cells were predicted and compared with those from the electrochemical heating. The difference between the two may be attributed to the lithium corrosion and other chemical reactions. The present program was also tested for charging of Li-SO2. In addition, the present methodology should be applicable to other primary cylindrical cells as well as rechargeable battery analyses with minor modifications. Author

**N88-11023*#** Altus Corp., San Jose, Calif.
**THE 250AH/90A ACTIVE LITHIUM-THIONYL CHLORIDE CELL FOR CENTAUR-G APPLICATION**
A. E. Zolla and D. D. Tura *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 61-72 Previously announced in IAA as A87-18100 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

A high rate active Li/SOCl2 cell was designed for use in a 28 volt, 250 amp-hour space battery system. The lithium battery is being considered as a replacement of its heavier silver-zinc counterpart on board the Centaur-G booster rocket which is used to launch payloads from the Space Shuttle cargo bay into deep-space. Basically a feasibility study, this development effort is demonstrating the ability of the lithium cell to deliver up to 90 amps safely at power densities of approximately 25 watts per pound. Test data on 4 prototype units is showing an energy density of 85 watt-hours per pound and 9.0 watt-hours/cu in. The cells tested typically delivered 280 to 300 amp-hours under ambient temperature test conditions using alternating continuous loads of 90, 55, and 20 amperes throughout life. Data from four cells tested are presented to demonstrate the capability of Li/SOCl2 technology for a C/3 discharge rate in active and hermetic cell units. IAA

**N88-11024*#** Moli Energy Ltd., Burnaby (British Columbia).
**THE MOLICEL(R) RECHARGEABLE LITHIUM SYSTEM: MULTICELL BATTERY ASPECTS**
D. Fouchard and J. B. Taylor *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 73-91 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

MOLICEL rechargeable lithium cells were cycled in batteries using series, parallel, and series/parallel connections. The individual cell voltages and branch currents were measured to understand the cell interactions. The observations were interpreted in terms of the inherent characteristics of the Li/MoS2 system and in terms of a singular cell failure mode. The results confirm that correctly configured multicell batteries using MOLICELs have performance characteristics comparable to those of single cells. Author

**N88-11025*#** Johns Hopkins Univ., Laurel, Md. Space Reliability Group.
**FAULT TREE SAFETY ANALYSIS OF A LARGE LI/SOCI(SUB)2 SPACECRAFT BATTERY**
O. Manuel Uy and R. H. Maurer *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 93-119 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The results of the safety fault tree analysis on the eight module, 576 F cell Li/SOCl2 battery on the spacecraft and in the integration and test environment prior to launch on the ground are presented. The analysis showed that with the right combination of blocking diodes, electrical fuses, thermal fuses, thermal switches, cell balance, cell vents, and battery module vents the probability of a single cell or a 72 cell module exploding can be reduced to .000001, essentially the probability due to explosion for unexplained reasons. B.G.

**N88-11026*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**CHEMICAL ANALYSIS OF CHARGED LI/SO(SUB)2 CELLS**
S. Subbarao, D. Lawson, H. Frank, G. Halpert, J. Barnes, and R. Bis (Naval Surface Weapons Center, Silver Spring, Md.) *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 121-137 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The initial focus of the program was to confirm that charging can indeed result in explosions and constitute a significant safety

problem. Results of this initial effort clearly demonstrated that cells do indeed explode on charge and that charging does indeed constitute a real and severe safety problem. The results of the effort to identify the chemical reactions involved in and responsible for the observed behavior are described. B.G.

**N88-11027*#** European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Energy Storage Section.
**BATTERY DEVELOPMENT AND TESTING AT ESA**
Jean Verniolle *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 141-165 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The principal activities of the Energy Storage Section of the Space Research and Technology Center (ESTEC) of the European Space Agency are presented. Nickel-hydrogen and fuel cell systems development are reported. The European Space Battery Test Center (ESBTC) facilities are briefly described along with the current test programs and results obtained. Author

**N88-11028*#** Aerospace Corp., Los Angeles, Calif.
**NICKEL HYDROGEN LOW EARTH ORBIT TEST PROGRAM UPDATE AND STATUS**
C. C. Badcock, S. W. Donley, A. B. Felts, and R. L. Haag (Naval Weapons Support Center, Crane, Ind.) *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 167-188 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The current status of nickel-hydrogen (NiH2) testing ongong at NWSC, Crane In, and The Aerospace Corporation, El Segundo, Ca are described. The objective of this testing is to develop a database for NiH2 battery use in Low Earth Orbit (LEO) and support applications in Medium Altitude Orbit (MAO). Individual pressure vessel-type cells are being tested. A minimum of 200 cells (3.5 in diameter and 4.5 in diameter) are included in the test, from four U.S. vendors. As of this date (Nov. 18, 1986) approximately 60 cells have completed preliminary testing (acceptance, characterization, and environmental testing) and have gone into life cycling. Author

**N88-11029*#** Yardney Electric Corp., Pawcatuck, Conn. Battery Div.
**ADVANCES IN NICKEL HYDROGEN TECHNOLOGY AT YARDNEY BATTERY DIVISION**
J. G. Bentley and A. M. Hall *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 189-208 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The current major activites in nickel hydrogen technology being addressed at Yardney Battery Division are outlined. Five basic topics are covered: an update on life cycle testing of ManTech 50 AH NiH2 cells in the LEO regime; an overview of the Air Force/industry briefing; nickel electrode process upgrading; 4.5 inch cell development; and bipolar NiH2 battery development. B.G.

**N88-11030*#** Martin Marietta Aerospace, Denver, Colo.
**FAILURE ANALYSIS OF A 3.5 INCH, 50 AMPERE-HOUR NICKEL-HYDROGEN CELL**
Kenneth H. Fuhr *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 209-213 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The 3.5 inch, 50 ampere-hour nickel-hydrogen cell was on a Low Earth Orbit (LEO) test regime and was being cycled at 10 C and 60 percent depth of discharge. At cycle number 511 the Automatic Control and Data Acquisition System (ACDAS) terminated the test when the end of discharge voltage dropped below the 1.00 volt cutoff. Upon removal of the stack assembly from the pressure vessel, portions of the zircar separator were found to be completely missing. Upon further examination portions of both the positive and negative plates were found to be missing from its substrate and several gas screens were damaged due to excessive heat which caused fusing. The postulated cause of failure is free electrolyte in the cell which caused oxygen channelization resulting in localized recombination which degraded the stack components. Author

**N88-11031*#** Grace (W. R.) and Co., Columbia, Md.
**GRACE DAKASEP ALKALINE BATTERY SEPARATOR**
R. T. Giovannoni, J. T. Lundquist, and W. M. Choi (Grace, W. R. and Co., Cambridge, Mass ) *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 215-222 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The Grace DAKASEP separator was originally developed as a wicking layer for nickel-zinc alkaline batteries. The DAKASEP is a filled non-woven separator which is flexible and heat sealable. Through modification of formulation and processing variables, products with a variety of properties can be produced. Variations of DAKASEP were tested in Ni-H2, Ni-Zn, Ni-Cd, and primary alkaline batteries with good results. The properties of DAKASEP which are optimized for Hg-Zn primary batteries are shown in tabular form. This separator has high tensile strength, 12 micron average pore size, relatively low porosity at 46-48 percent, and consequently moderately high resistivity. Versions were produced with greater than 70 percent porosity and resistivities in 33 wt percent KOH as low as 3 ohm cm. Performance data for Hg-Zn E-1 size cells containing DAKASEP with the properties shown in tabular form, are more reproducible than data obtained with a competitive polypropylene non-woven separator. In addition, utilization of active material is in general considerably improved. Author

**N88-11032*#** Empresa Brasileira de Telecomunicacoes S.A., Rio de Janeiro (Brazil). Space Segment Div.
**BRASILSAT A2: GROUND AND IN-ORBIT ANOMALIES**
Sergio Ricardo AzevedoFerreira *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 225-229 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

A description of the anomalies encountered during ground preparation for launch and in-orbit operation of Brasilsat A2 batteries is given. Processes used during recovery of these batteries and the improvement on main parameters are discussed, covering many cycles of reconditionings and behavior during September/86 eclipse charge/discharge cycles. Author

**N88-11033*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**INTERNATIONAL ULTRAVIOLET EXPLORER (IUE) SPACECRAFT BATTERY PERFORMANCE UPDATE**
Smith E. Tiller *In its* The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 231-246 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

January 26, 1987 marks the ninth inflight aniversary of the IUE spacecraft, launched into an eccentric synchronous orbit. The orbital path has subjected the spacecraft to 18 solar eclipse seasons since launch. Nine years of inflight operations culminate a major milestone for battery support to a spacecraft, which is well in excess of the initial 3 year design life. A brief outline of events, power system characteristics, and papers presented a previous battery workshops are provided. The IUE battery cell performance is excellent with the exception of the third electrode anomaly and temperature delta between batteries. Data indicates that battery depth-of-discharge (DOD) may be more critical to extend battery life than small operational temperature deltas between batteries. It is predicted that several additional years of

battery life may be obtained by a reduction in operational battery DOD. B.G.

**N88-11034*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**EARTH RADIATION BUDGET SATELLITE (ERBS) ORBITING PROFILES AND NI-Cd USE**
Marlon L. Enciso *In its* The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 247-255 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The Earth Radiation Budget Satellite (ERBS) is one of the more recently launched satellites of the Goddard Space Flight Center. The flight data of the two 50 Ah NASA standard batteries that are being flown on the ERBS are presented. Trend characteristics of the batteries were collected over a period of two years. The parameters that were trended are: the battery end-of-discharge voltage, time in peak power track, and time in constant current mode. All were plotted versus mission elapsed time. The slopes exhibited by the trended parameters indicate no adverse trends that would signify any appreciable degradation in the batteries. Author

**N88-11035*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**EFFECTS OF LONG TERM STORAGE ON AEROSPACE NICKEL CADMIUM CELL PERFORMANCE**
Thomas Y. Yi *In its* The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 257-276 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

Evaluation of the long term effects on aerospace nickel cadmium cells is described. A number of 6Ah and 12Ah capacity cells which were stored in shorted condition for 9 to 11 years at the Goddard Space Flight Center were selected for the study. Of the three tests which were initiated (initial and final destruction analyses of the test cells, electrical characterization tests, and life cycling tests) only the electrical characterization tests are completed; the other tests are scheduled to be completed by February 1987. The preliminary electrial performance data from the life cycling test and chemical composition data from the destructive testing indicate no anomalous behavior. Author

**N88-11036*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**QUALIFICATION TESTING OF GENERAL ELECTRIC 50 Ah NICKEL-CADMIUM CELLS WITH PELLON 2536 SEPARATOR AND PASSIVATED POSITIVE PLATES**
George W. Morrow *In its* The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 277-300 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

Forty-two 50 Ah nickel-cadmium cells were delivered to the Goddard Space Flight Center (GSFC) by General Electric (GE) in February, 1985 for the purpose of evaluating and qualifying a nonwoven nylon separator material, Pellon 2536, and the GE positive plate nickel attack control gas passivation process. Testing began May, 1985 at the Naval Weapons Support Center (NWSC) in Crane, Indiana with GSFC standard initial evaluation tests. Life cycling in both Low Earth Orbit (LEO) and Geosynchronous Orbit (GEO) began in July, 1985 with approximately 6500 LEO cycles and three GEO eclipse seasons completed. After early problems in maintaining test pack temperature control, all packs are performing well but are exhibiting higher than normal charge voltage characteristics. Author

**N88-11037*#** Colorado Univ., Boulder. Lab. for Atmospheric and Space Physics.
**FLIGHT EXPERIENCE OF SOLAR MESOSPHERE EXPLORER'S POWER SYSTEM OVER HIGH TEMPERATURES RANGES**
Jack Faber and Daniel Hurley *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 301-308 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The performance of the power system on the Solar Mesosphere Explorer (SME) satellite for the life of the mission and the techniques used to ensure power system health are summarized. Early in the mission high cell imbalances in one of the batteries resulted in a loading scheme which attemptod to minimize the cell imbalances without causing an undervoltage condition. A short term model of the power system allowed planners to predict depth of discharge using the latest available data. Due to expected orbital shifts the solar arrays experience extended periods of no eclipse. This has required special conditioning schemes to keep the batteries healthy when the eclipses return. Analysis of the SME data indicates long term health of the SME power system as long as the conditioning scheme is continued. Author

**N88-11038*#** Aerospace Corp., El Segundo, Calif. Chemistry and Physics Lab.
**REAL TIME CHARGE EFFICIENCY MONITORING FOR NICKEL ELECTRODES IN NICD AND NIH2 CELLS**
A. H. Zimmerman *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 311-333 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

The charge efficiency of nickel-cadmium and nickel-hydrogen battery cells is critical in spacecraft applications for determining the amount of time required for a battery to reach a full state of charge. As the nickel-cadmium or nickel-hydrogen batteries approach about 90 percent state of charge, the charge efficiency begins to drop towards zero, making estimation of the total amount of stored charge uncertain. Charge efficiency estimates are typically based on prior history of available capacity following standardized conditions for charge and discharge. These methods work well as long as performance does not change significantly. A relatively simple method for determining charge efficiencies during real time operation for these battery cells would be a tremendous advantage. Such a method was explored and appears to be quite well suited for application to nickel-cadmium and nickel-hydrogen battery cells. The charge efficiency is monitored in real time, using only voltage measurements as inputs. With further evaluation such a method may provide a means to better manage charge control of batteries, particularly in systems where a high degree of autonomy or system intelligence is required. Author

**N88-11039*#** Boeing Aerospace Co., Seattle, Wash.
**STATISTICALLY DETERMINED NICKEL CADMIUM PERFORMANCE RELATIONSHIPS**
Sidney Gross *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop Sep. 1987 p 335-342 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

A statistical analysis was performed on sealed nickel cadmium cell manufacturing data and cell matching data. The cells subjected to the analysis were 30 Ah sealed Ni/Cd cells, made by General Electric. A total of 213 data parameters was investigated, including such information as plate thickness, amount of electrolyte added, weight of active material, positive and negative capacity, and charge-discharge behavior. Statistical analyses were made to determine possible correlations between test events. The data show many departures from normal distribution. Product consistency from one lot to another is an important attribute for aerospace applications. It is clear from these examples that there are some significant differences between lots. Statistical analyses are seen to be an excellent way to spot those differences. Also, it is now proven beyond doubt that battery testing is one of the leading causes of statistics. B.G.

**N88-11040*#** Eagle-Picher Co., Joplin, Mo.
**TEST SUMMARY FOR ADVANCED H2 CYCLE NI-CD CELL**
Lee Miller *In* NASA Goddard Space Flight Center, Greenbelt, Md. The 1986 Goddard Space Flight Center Battery Workshop

Sep. 1987 p 343-350 (For primary document see N88-11021 02-33)
Avail: NTIS HC A16/MF A01 CSCL 10C

To improve operational tolerances and mass, the H2 gas recombination design provisions of the Ni-H2 system were incorporated into the sealed Ni-Cd system. Produced is a cell design capable of operating on the H2 cycle versus the normal O2 cycle. Three test cells have now completed approximately 4,330 LEO (90 minute) cycles at 20 percent depth of discharge (DOD). Performance remains stable although one cell exhibited a temporary pressure anomaly. Author

**N88-11041#** Oak Ridge National Lab., Tenn. Chemical Technology Div.
**PHOTOCATALYTIC ELECTROCHEMISTRY AT A BIOLOGICAL-MEMBRANE METAL-COLLOID INTERFACE**
Elias Greenbaum 18 Oct. 1987 2 p Presented at the 172d Meeting of the Electrochemical Society, Honolulu, Hawaii, 18-23 Oct. 1987
(Contract DE-AC05-84OR-21400)
(DE87-009122; CONF-871027-10) Avail: NTIS HC A02

A method for electrically contacting the electron-transport chain of photosynthesis is described. Colloidal platinum was prepared and precipitated directly onto photosynthetic thylakoid membranes from aqueous solution, and entrapped on fiberglass filter paper. This composition of matter was capable of sustained simultaneous photoevolution of hydrogen and oxygen when irradiated at any wavelength in the chlorophyll absorption spectrum. Experimental data support the interpretation that part of the platinum metal catalyst is precipitated adjacent to the photosystem-I reduction site of photosynthesis and the electron-transfer occurs across the interface between photosystem I and the catalyst. Photoactivity of the material was dependent on the nature of the ionic species from which the platinum was precipitated. When contacted with metal electrodes, the thylakoid-platinum combination is capable of generating a sustained flow of current through an external load resistor. DOE

**N88-11042#** Sandia National Labs., Albuquerque, N. Mex.
**VOLTAMMETRIC INVESTIGATION OF POROUS SILICON FOR INTEGRATED CIRCUIT APPLICATIONS**
Michael Kelly, Terry Guilinger, and Sylvia Tsao 1987 7 p Presented at the 172d Meeting of the Electrochemical Society, Honolulu, Hawaii, 18-23 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-009287; SAND-87-1110C; CONF-871027-13) Avail: NTIS HC A02/MF A01

Silicon-on-insulator (SOI) is the generic name for one class of full dielectric isolation. There are several techniques for achieving desired SOI structures, including zone melt recrystallization, high dose oxygen or nitrogen implantation, and oxidation of porous silicon. We utilize the directed growth of porous silicon (PS) to isolate silicon islands upon which microcircuits will be fabricated. The porous silicon is then thermally oxidized to produce a fully dense, insulating silicon dioxide layer. Silicon can be made porous by making it the anode in an electrochemical cell containing aqueous hydrofluoric acid (HF). We present the results of a voltammetric study of the electrochemical reaction mechanism of PS formation in dilute HF. It can be stated that larger overpotentials (and resultant larger porous silicon formation rates) are required in more concentrated HF solutions to produce a large enough rate of SiO2 formation to passivate the electrode. DOE

**N88-11043#** Sandia National Labs., Albuquerque, N. Mex.
**TRAJECTORY VERSUS PIC METHODS IN DIODE DESIGN**
J. W. Poukey 1987 5 p Presented at the 12th Conference on the Numerical Simulation of Plasmas, San Francisco, Calif., 20 Sep. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012135; SAND-87-1693C; CONF-870947-2) Avail: NTIS HC A02/MF A01

This report discusses an automated method of computing electron trajectories in electron diodes. The advantages of the method are stated to be improved efficiency and lack of noise. Computations using this method compared favorably with older methods. DOE

**N88-11044#** Sandia National Labs., Albuquerque, N. Mex. Storage Batteries Div.
**RESULTS OF A WIND TURBINE/SEALED LEAD-ACID BATTERY EXPERIMENT**
J. M. Freese, P. C. Butler, and R. A. Cowan (On Site Energy, Portland, Oreg.) 1987 16 p Presented at the 172d Meeting of the Electrochemical Society, Honolulu, Hawaii, 18 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012720; SAND-87-1093C; CONF-871027-30) Avail: NTIS HC A03/MF A01

A coupled, stand-alone wind turbine generator/battery storage system has been evaluated by Sandia National Laboratories (SNL). The goal was to evaluate advanced batteries in solar applications. This paper addresses the system components, instrumentation, operation, and some of the results obtained during this evaluation. This system evaluation demonstrated that advanced lead-acid batteries can be successfully used with wind turbines to reliably satisfy an actual energy demand. DOE

**N88-11045#** Oak Ridge National Lab., Tenn.
**DIELECTRIC RESPONSE OF IONIC CONDUCTORS**
J. B. Bates and J. C. Wang Jul. 1987 12 p Presented at the 6th International Conference on Solid State Ionics, Garmisch-Partenkirchen, West Germany, 6 Sep. 1987
(Contract DE-AC05-84OR-21400)
(DE87-013552; CONF-870911[illegible]) Avail: NTIS HC A03/MF A01

Impedance measurements on (ZrO2)/sub 0.87 (Y2O2) sub 0.13 in the range from 0.1 Hz to 10 MHz reveal an apparent frequency dependent conductivity that is typical of ionic conductors. Analysis of the impedance and the dielectric permittivity using empirical expressions for dielectric relaxation such as the Havriliak-Negami function shows that the frequency dependence of the conductivity can be attributed to dipole relaxation of defects, possibly (V sub 0 Y) -Y' pairs, with relaxation times that are determined by the hopping rate of oxygen vacancies. DOE

**N88-11046#** Oak Ridge National Lab., Tenn.
**SURFACE TOPOGRAPHY AND ELECTRICAL RESPONSE OF METAL-ELECTROLYTE INTERFACE**
J. B. Bates and Y. T. Chu Jul. 1987 25 p Presented at the 6th International Conference on Solid State Ionics, Garmisch-Partenkirchen, West Germany, 6 Sep. 1987
(Contract DE-AC05-84OR-21400)
(DE87-013553; CONF-8709116-1) Avail: NTIS HC A03/MF A01

The small-signal impedance of chemical cells with blocking electrodes is dominated at low frequencies (f less than approx 100 Hz) by the impedance of the metal-electrolyte interfaces which is accurately represented by Z(sub i) = A(j omega)sup -n. The frequency exponent n(n less than 1) is sensitive to the texture of the interface, and several recent theories have been proposed that relate n to the fractal dimension d-bar of the rough interface. However, we have found no correlation between n and d-bar from experiments using aqueous electrolytes and metal and semiconductor electrodes. A new model for the transient response of a rough electrode-electrolyte interface to a constant voltage pulse is proposed. Computer simulations, similar to the diffusion limited aggregation model, using measured profiles as a fixed (non-growing) cluster, gave exponents n in good agreement with experiments. DOE

**N88-11047#** Lawrence Livermore National Lab., Calif.
**A SIMPLE SELF-BREAKING 2 MV GAS SWITCH**
M. S. DiCapua, E. K. Freytag, W. R. Dixon, and R. A. Hawley 29 Jun. 1987 6 p Presented at the 6th Institute of Electrical and Electronic Engineers Pulsed Power Conference, Arlington, Va., 29 Jun. 1987
(Contract W-7405-eng-48)

(DE87-014346; UCRL-96263; CONF-870656-45) Avail: NTIS HC A02

Described is a simple self-breaking 2 MV gas master switch for the LLNL 2 MV general purpose relativistic electron beam (REB) accelerator. The switch cavity has been hollowed out in a 17.8 cm-thick acrylic slab. The switch gap is 3.55 cm. At 2 MV the maximum field at the cathode is 740 kV/cm and the maximum envelope field is 172 kV/cm. The maximum measured switching voltage is 1.90 +/- 0.1 MV (10 bar abs). The minimum switching voltage is 1.1 MV (4.3 bar abs). The operating characteristics break away from the 89 kV/(cm atm) dc breakdown strength of SF at 5 bar abs. Careful electrical and mechanical design as well as strict quality control during assembly and operation have resulted in a reliable and reproducible operation. DOE

**N88-11048#** Tennessee Univ., Knoxville. Dept. of Electrical Engineering.

**PROCESS SUPPORT COMPRESSOR MOTOR ELECTROMAGNETIC DESIGN SUMMARY**

J. M. Bailey Mar. 1987 31 p
(Contract DE-AC05-84OT-21400)
(DE87-014359; K/SUB-85-03528/2) Avail: NTIS HC A03/MF A01

A 30-hp, 15,000-rpm, permanent magnet motor has been designed and is now being built. The direct drive motor has 72 slots and eight poles. Using A. O. Smith Magnetic, a flux plot was obtained and the flux density throughout one pole pitch has been determined. The poles are connected in a four-pole series, parallel WYE. Each pole requires 30 A for a total per phase current of 60 A. The torque capability is 2638 oz-in. DOE

**N88-11049#** Oak Ridge Gaseous Diffusion Plant, Tenn.

**DESIGN VERIFICATION TESTS FOR AN AXIAL GAP PERMANENT MAGNET COMPRESSOR MOTOR**

R. A. Hawsey and J. M. Bailey Jul. 1987 15 p Prepared in cooperation with Tennessee Univ., Knoxville
(Contract DE-AC05-84OT-21400)
(DE87-014360; K/ETAC-30) Avail: NTIS HC A03/MF A01

A 30-hp, direct-drive, permanent magnet motor (PMM) has been constructed. The motor is to operate at 15,000 rpm and is designed to drive a Worthington compressor at the US DOE-owned gaseous diffusion plants. The PMM prevents traditional dynamometer testing, including locked rotor current, voltage, and torque measurements. A test plan is presented for data acquisition on the dynamometer test stand in order to calculate the equivalent circuit for the motor. A description of the hardware required for these measurements is included in the plan. DOE

**N88-11050*#** Michigan Univ., Ann Arbor. Space Physics Research Lab.

**RESEARCH RELATIVE TO AN ADVANCED ROD CONTROL SYSTEM FOR QUADRUPOLE MASS SPECTROMETRY APPLICATIONS Final Report**

George R. Carignan Nov. 1987 46 p
(Grant NAG5-803)
(NASA-CR-181458; NAS 1.26:181458) Avail: NTIS HC A03/MF A01 CSCL 09A

The design of a suitable amplifier output stage using available transistors and passive components is summarized. All of the analysis and calculation confirm that it is feasible to design the amplifier and quadrupole coupling circuit needed for the Advanced Rod Control System. The progress obtained so far concerning the three frequency tank circuits to be used in the oscillator for the mass spectrometer of the Cometary Rendezvous Asteroid Flyby (CRAF) project is presented. Results from this study look promising. However, it is not known what minimum impedance levels are required to make it possible for the oscillator to work properly. Therefore, it is necessary to construct a prototype circuit in the laboratory which can be measured and tested in an oscillator circuit. Continued attempts will be made to develop a useful inductor motor with better characteristics than the one being used at the moment. It is important that such a model be found if computer simulation is to reflect reality more closely. B.G.

**N88-11051#** Sandia National Labs., Albuquerque, N. Mex.

**PROGRESS TOWARD A SUPERCONDUCTING OPENING SWITCH**

D. R. Humphreys, T. L. Francavilla, D. U. Gubser, and S. A. Wolf (Naval Research Lab., Washington, D.C.) 1987 5 p Presented at the 6th Institute of Electrical and Electronic Engineers Pulsed Power Conference, Arlington, Va., 29 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-014170; SAND-87-0128C; CONF-870656-44) Avail: NTIS HC A02/MF A01

Recent developments in superconducting materials should be of interest to the pulsed power community. Nitride films have been made which can carry high currents (approx. 10 MA/sq cm) in their superconducting state, yet which have a moderately high resistivity (approx. 100 microohm-cm) in their normal state. Laser light of moderate energy triggers the transition in nanoseconds. The new high-temperature oxide superconductors show promise of having similar critical current densities but higher normal-state resistivities (approx. 1000 microohm-cm). These properties raise the possibility of making a superconducting fast opening switch. In conjunction with superconducting inductive energy storage (approx. 100 MJ/cu m), such a switch could provide the basis for very compact Terawatt pulsed power generators. Here we show some of the possible configurations, physical constraints, and scaling laws for such systems. DOE

**N88-11052#** Wisconsin Univ., Madison. Dept. of Electrical and Computer Engineering.

**COMPARISON OF COSTS AND BENEFITS FOR dc AND ac TRANSMISSION**

W. F. Long and J. P. Stovall (Oak Ridge National Lab., Tenn.) Apr. 1987 8 p Presented at the CIGRE AC/DC Transmission Interactions and Comparison Symposium, Boston, Mass., 28 Oct. 1987
(Contract DE-AC05-84OR-21400)
(DE87-008774; CONF-871083-1-Summ) Avail: NTIS HC A02/MF A01

This paper summarizes the results of a study conducted by the US Department of Energy, Office of Energy Storage and Distribution, to determine generic cost differences between dc and ac systems, and to identify situations where dc is clearly advantageous for long distance and bulk power transport. Data are presented which can aid in determining dc converter station costs as a function of megawatt rating, dc voltage, and ac voltage. Transmission system cost data are also presented. DOE

**N88-11053#** National Lab. for High Energy Physics, Oho (Japan).

**PERFORMANCE OF HIGH POWER S-BAND KLYSTRONS FOCUSED WITH PERMANENT MAGNET**

S. Fukuda, T. Shidara, Y. Saito, H. Hanaki, K. Nakao, H. Homma, S. Anami, and J. Tanaka Feb. 1987 43 p
(DE87-753024; KEK-86-9) Avail: NTIS (US Sales Only) HC A03/MF A01

Performance of high power S-band klystrons focused with permanent magnet is presented. The axial magnetic field distribution and the transverse magnetic field play an important role in the tube performance. Effects of the reversal field in the collector and the cathode-anode region are discussed precisely. It is also shown that the tube efficiency is strongly affected with the residual transverse magnetic field. The allowable transverse field is less than 0.3 percent of the longitudinal field in the entire RF interaction region of the klystron. DOE

**N88-11054#** Toulouse Univ. (France). Lab. d'Automatique et d'Analyse des Systemes.

**STUDY AND REALIZATION OF SCHOTTKY DIODES FOR FORTHCOMING INTEGRATED HYPERFREQUENCY DEVICES Ph.D. Thesis - Ecole Nationale Superieure de l'Aeronautique et de l'Espace**

Zeggai Souar 1987 162 p In FRENCH; ENGLISH summary
(LAAS-87-062; ETN-87-90640) Avail: NTIS HC A08/MF A01

The optimum functions for detection, mixing, and harmonics generation with minimum losses and high cut-off frequencies are studied. An approach to the analysis of diode dimensions and substratum donor impurities concentration is presented. Pulsed electroplating metallizing and electronic lithography insolation are described. The influence of manufacturing processes is assessed. The feasibility of submicronic AsGa diodes is demonstrated. ESA

**N88-11055#** Toulouse Univ. (France). Lab. d'Automatique et d'Analyse des Systemes.
**SURFACE EFFECTS AND LOW FREQUENCY NOISES IN GaAs FIELD EFFECT TRANSISTORS Ph.D. Thesis - Paul Sabatier Univ.**
Michel Pouysegur 1987 157 p In FRENCH; ENGLISH summary
(LAAS-87-179; ETN-87-90913) Avail: NTIS HC A08/MF A01

A thermal surface noise model is presented. An investigation of the GaAs surface electrical properties shows that a major contribution to low frequency noise is related to surface leakage resistance and the charge fluctuations of the surface states. The validity of the model is investigated in a large variety of devices. A close correlation between the interelectrode surface electric characteristics and the low frequency noise behavior is found. From this model technological improvements are proposed. ESA

**N88-11056#** Thomson-CSF, Velizy (France). Div. Tubes Electriques.
**IMPROVED CATHODE LIFE TESTING Final Report**
A. M. Shroff and J. C. Tonnerre Paris, France ESA Sep. 1986 103 p
(Contract ESTEC-5525/83-NL-GM(SC))
(Rept-3189-T; ESA-CR(P)-2430; ETN-87-90920) Avail: NTIS HC A06/MF A01

Production of tungsten-osmium mixed matrices, and tests in gridded anode diodes are summarized. Fourteen diodes were mounted with well controlled cathodes and tested at 950, 1000, 1040 and 1100 CB for a space charge load of 2 A/sqcm. All diodes reached 10,000 hr without any noticeable current variation. A manufacture flow chart and specifications were written. A life prediction model based on work function and coverage evolution versus time used on these cathodes suggests lives of greater than 200 Khr at operating temperatures of 950 and 1000 CB. ESA

**N88-11057#** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Werner-Heisenberg-Inst. fuer Physik.
**LOW NOISE-LOW POWER MONOLITHIC MULTIPLEXING READOUT ELECTRONICS FOR SILICON STRIP DETECTORS**
W. Buttler, G. Lutz, H. Bergmann, D. Hauff, P. Holl, and P. F. Manfredi Jul. 1987 17 p Presented at the International Europhysics Conference on High Energy Physics, Uppsala, Sweden, 25 Jun.-1 Jul. 1987
(MPI-PAE/Exp.El.178; ETN-87-91041) Copyright Avail: NTIS HC A02/MF A01

A 128 channel readout chip suitable for readout with 50 micron pitch was developed in CMOS technology. It provides signal amplification, parallel data storage, and serial readout. Switched capacitor technique is used for noise reduction by multicorrelated sampling and simultaneously for second stage amplification. Power consumption is controlled by an externally applied reference voltage, allowing for an optimization of speed and noise versus power consumption. Pulsed mode operation for further reduction of heat dissipation is easily possible without cutting the supply voltages. Very good noise performance, low imput impedance and large amplification are obtained at very low power consumption. The chip may be used for both synchronous (e.g., collider) and asynchronous (fixed target) applications where the time of the event is not known in advance. ESA

**N88-11058#** National Bureau of Standards, Gaithersburg, Md. Center for Electronics and Electrical Engineering.
**CENTER FOR ELECTRONICS AND ELECTRICAL ENGINEERING TECHNICAL PROGRESS BULLETIN COVERING CENTER PROGRAMS, OCTOBER TO DECEMBER 1986 WITH 1987 CEEE EVENTS CALENDAR**
E. J. Walters Jul. 1987 29 p
(PB87-226890; NBSIR-87/3577) Avail: NTIS HC A03/MF A01 CSCL 09C

This is the seventeenth issue of a quarterly publication providing information on the technical work of the National Bureau of Standards Center for Electronics and Electrical Engineering. This issue of the CEEE Technical Progress Bulletin covers the fourth quarter of the calendar year 1986. Abstracts are provided by technical area for both published papers and papers approved by NBS for publication. GRA

**N88-11059#** National Bureau of Standards, Gaithersburg, Md. Center for Electronics and Electrical Engineering.
**CENTER FOR ELECTRONICS AND ELECTRICAL ENGINEERING TECHNICAL PUBLICATION ANNOUNCEMENTS COVERING CENTER PROGRAMS, JULY TO SEPTEMBER 1986 WITH 1987 CEEE EVENTS CALENDAR**
E. J. Walters Jul. 1987 19 p
(PB87-223442; NBSIR-87/3600) Avail: NTIS HC A03/MF A01 CSCL 09C

This is the tenth issue of a quarterly publication providing information on the technical work of the National Bureau of Standards Center for Electronics and Electrical Engineering. This issue of the Center for Electronics and Electrical Engineering Technical Publication Announcements covers the third quarter of the calendar year 1986. Abstracts are provided by technical area for papers published this quarter. GRA

**N88-11060*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**ANALYTICAL CAUSTIC SURFACES**
R. F. Schmidt Apr. 1987 45 p
(NASA-TM-87805; Rept-87B0244; NAS 1.15:87805) Avail: NTIS HC A03/MF A01 CSCL 09A

This document discusses the determination of caustic surfaces in terms of rays, reflectors, and wavefronts. Analytical caustics are obtained as a family of lines, a set of points, and several types of equations for geometries encountered in optics and microwave applications. Standard methods of differential geometry are applied under different approaches: directly to reflector surfaces, and alternatively, to wavefronts, to obtain analytical caustics of two sheets or branches. Gauss/Seidel aberrations are introduced into the wavefront approach, forcing the retention of all three coefficients of both the first- and the second-fundamental forms of differential geometry. An existing method for obtaining caustic surfaces through exploitation of the singularities in flux density is examined, and several constant-intensity contour maps are developed using only the intrinsic Gaussian, mean, and normal curvatures of the reflector. Numerous references are provided for extending the material of the present document to the morphologies of caustics and their associated diffraction patterns. Author

**N88-10809#** Electronique Serge Dassault, St. Cloud (France).
**DEDALE: AN EXPERT SYSTEM FOR ANALOG CIRCUIT MAINTENANCE**
Michel Muenier and Philippe Deves *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

# 34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

**N88-11061** Arizona State Univ., Tempe.
**ON THE MODELLING OF NON-REACTIVE AND REACTIVE TURBULENT COMBUSTOR FLOWS Ph.D. Thesis**
Mohammed Nikjooy 1987 284 p
Avail: Univ. Microfilms Order No. DA8713672

A numerical study of non-reactive and reactive axisymmetric combustor flows with and without swirl is presented. Closure of the Reynolds equations is achieved by three different levels of models: kappa-epsilon, algebraic stress, and Reynolds stress closure. Performance of two locally non-equilibrium, and one equilibrium algebraic stress model is analyzed assuming four different pressure-strain models. A comparison is also made of the performance of a high and a low Reynolds number model for combustor flow calculations using Reynolds stress closures. Effects of diffusion and pressure-strain models on these closures are also investigated. Two models for the scalar transport are presented. One employs the second moment closure which solves the transport equations for the scalar fluxes, while the other solves the algebraic equations for the scalar fluxes. In addition, two cases of non-premixed and one case of premixed combustion are considered. Fast- and finite-rate chemistry models are applied to non-premixed combustion. Both models show promise for application in gas turbine combustors. However, finite-rate chemistry models, which are more realistic, need to be further examined to establish a suitable coupling of the heat release effects on the turbulence field and the rate constants. Dissert. Abstr.

**N88-11062#** Sandia National Labs., Albuquerque, N. Mex. Computational Physics and Mechanics Div.
**COMPUTATIONS OF HYPERVELOCITY IMPACT USING THE CTH SHOCK WAVE PHYSICS CODE**
Frederick J. Zeigler, J. Michael McGlaun, Samuel L. Thompson, and Timothy G. Trucano 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-013067; SAND-87-0725C; CONF-870753-57) Avail: NTIS HC A02/MF A01

Computer simulations of several hypervelocity impact events using the multi-dimensional, multi-material CTH shock wave physics code are presented and discussed. First, some two-dimensional CTH calculations are presented. These are then compared with calculations using another Eulerian shock wave physics code (CSQ) and with flash X-ray photographs of the impact events. Fully three-dimensional computations, including simulations of oblique impacts, are then presented. Possible improvements in the physical and computational models used in the calculations are mentioned. The influence of these calculations on CTH development is discussed. DOE

**N88-11063#** Lawrence Livermore National Lab., Calif. Theoretical Div.
**MODELING SHOCKWAVE DEFORMATION VIA MOLECULAR DYNAMICS**
Brad Lee Holian 1987 7 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20-23 Jul. 1987
(Contract W-7405-eng-36)
(DE87-013157; LA-UR-87-2367; CONF-870753-46) Avail: NTIS HC A02

Molecular dynamics (MD), where the equations of motion of up to thousands of interacting atoms are solved on the computer, has proven to be a powerful tool for investigating a wide variety of nonequilibrium processes from the atomistic viewpoint. Simulations of shock waves in three-dimensional (3D) solids and fluids have shown conclusively that shear-stress relaxation is achieved through atomic rearrangement. In the case of fluids, the transverse motion is viscous, and the constitutive model of Navier-Stokes hydrodynamics has been shown to be accurate, even on the time and distance scales of MD experiments. For strong shocks in solids, the plastic flow that leads to shear-stress relaxation in MD is highly localized near the shock front, involving a slippage along close-packed planes. For shocks of intermediate strength, MD calculations exhibit an elastic precursor running out in front of the steady plastic wave, where slippage similar in character to that in the very strong shocks leads to shear-stress relaxation. An interesting correlation between the maximum shear stress and the Hugoniot pressure jump is observed for both 3D and fluid shockwave calculations, which may have some utility in modeling applications. At low shock strengths, the MD simulations show only elastic compression, with no permanent transverse atomic strains. The result for perfect 3D crystals is also seen in calculations for 1D chains. It is speculated that, if it were practical, a very large MD system containing dislocations could be expected to exhibit more realistic plastic flow for weak shock waves, too. DOE

**N88-11064#** Lawrence Livermore National Lab., Calif.
**LOCATING PARALLEL NUMERICAL TASKS IN THE SOLUTION OF VISCOUS FLUID FLOWS**
G. Rodrigue and A. L. Perkins 14 Jul. 1987 20 p Presented at the 4th Deutsche Forschungs-und Verschesanstalt fuer Fult-und Raumfahart Conference, Cologne, Fed. Republic of Germany, 25 Jun. 1987 Prepared in cooperation with California Univ., Davis
(Contract W-7405-eng-48)
(DE87-013510; UCRL-96835; CONF-8706181-1) Avail: NTIS HC A03/MF A01

A parallel processing technique is presented for the two dimensional heat equation. The solution is considered for a small time interval with an initial condition that possesses a sharp gradient. DOE

**N88-11065#** Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.
**FLOW AND HEAT TRANSFER WITH IMPINGING JETS AND ROUGH SURFACES Final Report, 1 Nov. 1980 - 31 Dec. 1986**
R. J. Goldstein and M. Y. Jabbari Jul. 1987 8 p
(Contract DE-AC02-81ER-10810)
(DE87-014162; DOE/ER-10810/2) Avail: NTIS HC A02/MF A01

A series of studies were undertaken to investigate heat transfer from impinging jets and rough surfaces. In some of the studies, liquid crystals and naphthalene sublimation techniques were developed and used to determine the temperature distribution and the heat (mass) transfer coefficients, respectively. In the process of these investigations, a new data acquisition system, operated and controlled by computers, was developed, constructed, tested, and employed. A Laser-Doppler velocimeter was used to measure velocity and Reynold stresses in a two-dimensional wall jet. Single, multiple, and oblique jets, and the effects of entrainment and confinement on impingement heat transfer were studied. Investigations of three-dimensional heat (mass) transfer at the base of a cylinder protruding from a surface was carried out. Similar tests with an array of in-line and staggered cylinders were also conducted. The local heat transfer from a surface covered with two-dimensional periodic ribs was investigated. Distribution of the heat transfer coefficient on bottom and sidewall surfaces of a two dimensional cavity was experimentally determined. DOE

**N88-11066#** Los Alamos National Lab., N. Mex.
**DIMENSION DENSITIES FOR TURBULENT SYSTEMS WITH SPATIALLY DECAYING CORRELATION FUNCTIONS**
G. Mayer-Kress and T. Kurz 1986 11 p Presented at the Modern Approaches To Large Nonlinear Physical Systems Workshop, Santa Fe, N. Mex., 27 Oct. 1986
(Contract W-7405-eng-36)
(DE87-010119; LA-UR-87-1627; CONF-8610281-1) Avail: NTIS HC A02/MF A01

The introduction of nonlinear, deterministic, and low-dimensional dynamical systems with chaotic solutions led to many conjectures about how these chaotic systems might be related to fluid turbulence. It appears that the time series, produced by a chaotic solution can be as complex as experimentally observed signals from turbulent hydrodynamics. Furthermore, certain transitions from laminar to turbulent flow have their analog in the transition from ordered to chaotic behavior of deterministic chaotic systems. A basic problem in this context is how far methods from nonlinear dynamical systems can be used to describe experimental turbulence. A frequent objection to the approach of using simple dynamical systems as models for turbulence is that these models might reproduce some temporal chaos but would not correspond to real turbulence, for which the spatial structure also is very irregular and chaotic. The dynamics of a turbulent flow are not expected to be spatially coherent and therefore cannot be described by a few global modes. In the following we use the simplest of coupled maps in order to test the applicability of some ideas which should make it possible to estimate the number of degrees of freedom per unit length of a system which is spatially incoherent. This is done by computing the dimension density of the lattice system through a series of two-point measurements at separated lattice points. Then we compare these results with the spatial decay of the correlation function and also of the mutual information content. We find a qualitative agreement with the expected dependence. For precise quantitative measurements the general problem of accuracy and data limitations appear to become dominant. DOE

**N88-11067#** Lawrence Livermore National Lab., Calif.
**SHOCK-INDUCED COOLING IN DENSE FLUIDS**
H. B. Radousky Jul. 1987 7 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract W-7405-eng-48)
(DE87-014343; UCRL-96527; CONF-870753-71) Avail: NTIS HC A02

Radiative temperatures have been measured for fluid nitrogen which has been single shocked to pressures of 18 to 81 (180 to 810 kbar) and then double shocked against both Al2O3 and LiF windows. Shock temperatures are particularly interesting in materials such as nitrogen, which undergoes a continuous dissociative phase transition starting at 30 GPa and 7000° K. In nitrogen, the dissociative transition leads to a new effect, which is shock-induced cooling. Preliminary results indicate that xenon provides a second example of the effect in a dense fluid system. The phenomenon depends on the existence of an absorption mechanism or energy sink in the material which changes rapidly with density. For nitrogen this is molecular to non-molecular dissociation, while for xenon the mechanism is the excitation of electrons over a rapidly closing energy gap. DOE

**N88-11068#** British Library Lending Div., Boston Spa (England).
**AN APPROXIMATE SOLUTION TO THE PROBLEM OF HEATING MASSIVE BODIES BY BOTH RADIATION AND CONVECTION**
V. M. Olshanskii 1987 7 p Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy Chernaya Metallurgiya (USSR), no. 1, 1987 p 121-124
(BLL-M-37315-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

The reasoning leading to equations for solving the problem of the heating of massive bodies by a combination of radiation and convection is given. Calculations using the equations provide results which agree satisfactorily with those of computer calculations. Author

**N88-11069#** National Aerospace Lab., Tokyo (Japan).
**FDM-FEM ZONAL METHOD FOR VISCOUS FLOW COMPUTATIONS OVER MULTIPLE-BODIES**
Kozuhiro Nakahashi and Shigeru Obayashi Mar. 1987 14 p
(NAL-TR-925T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

A hybrid method between a finite-difference method (FDM) and a finite-element method (FEM) is developed for computations of two and three dimensional viscous flowfields over multiple bodies. In this scheme, an implicit finite-difference method is applied to viscous flow regions bodies with body-fitted grids, and those FDM-zones are patched together by solving the remaining region using an explicit FEM. With this zonal approach, the computational efficiency and the solution quality of the FDM are retained, and geometric flexibility is given by the FEM. The most important advantage the present technique yields is that the flow solver with this FDM-FEM zonal approach can be applied to various kinds of multiple-body flow problems without modifying the basic solution procedure. Flowfields of a 2-D turbine cascade and a 3-D nacelle/inlet are numerically simulated by the method in order to validate its capabilities. Effects on convergence rate due to different CFL values and the variable time step are also explored. Author

**N88-11070#** Institut National de Recherche d'Informatique et d'Automatique, Rocquencourt (France).
**NUMERICAL SOLUTION OF EULER EQUATIONS FOR COMPRESSIBLE FLUIDS BY THE FINITE ELEMENT METHOD, VOLUME 3 Final Report [RESOLUTION NUMERIQUE DES EQUATIONS D'EULER POUR LES FLUIDES COMPRESSIBLES PAR DES METHODES D'ELEMENTS FINIS]**
Dec. 1986 66 p In FRENCH
(Contract DRET-84-34-014-00-470-75-01)
(ETN-87-90650) Avail: NTIS HC A04/MF A01

The numerical solutions of steady flow Euler equations were studied using an asymptotic method with equations formulated in conservative primitive variables. An explicit scheme and a Richtmyer-Galerkin scheme were tried in several finite element contexts, including artificial viscosity, gliding conditions and several boundary condition configurations. The exploration of a Runge-Kutta scheme was used to develop an explicit version without matrix, twice as fast as the base version. A finite volume/finite element hybrid formulation is adopted for first order out of center schemes. ESA

**N88-11071#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**OPTICAL FIBER INTERFEROMETRIC SENSOR TO MEASURE TEMPERATURE IN GAS FLOW Ph.D. Thesis [CAPTEUR INTERFEROMETRIQUE A FIBRE OPTIQUE POUR LA MESURE DES TEMPERATURES DANS LES ECOULEMENTS GAZEUX]**
Chieh Liu Apr. 1987 149 p In FRENCH
(ENST-87E006; ISSN-0751-1353; ETN-87-90662) Avail: NTIS HC A07/MF A01

Interferometric structures and signal detection methods are examined to select the best technology for an interferometric transducer to measure static temperatures of supersonic gas flow. Single arm Michelson interferometers and synchronous zerodynamics detection are chosen to implement an experimental device. An excellent resolution (0.5K) is found. A design including temperature-resistant optical elements, capable of measuring inside a turbine is also discussed. ESA

**N88-11072#** National Aerospace Lab., Amsterdam (Netherlands). Space Div.
**A PRELIMINARY STUDY OF A FLUID SCIENCE LABORATORY FOR SPACE STATION (COLUMBUS). PART 4: EXECUTIVE SUMMARY Final Report**
I. DaRiva, I. Martinez, R. Martinez-Val, A. Sanz, R. H. Huijser, F. B. Visser, and J. P. B. Vreeburg Paris, France ESA 30 Jan. 1987 20 p
(Contract ESA-6506/85-F-FL(SC))
(NLR-TR-87023-L-Pt-4; ESA-CR(P)-2437-Pt-4; ETN-87-90893)
Avail: NTIS HC A03/MF A01

The scientific background, techniques, and facilities for a microgravity fluid science laboratory (FSL) on Columbus are outlined. The FSL provides for self-contained experiment cells, for

on-orbit configuration of liquid, including continuous flow experiments, and allows accommodation of unspecified facilities. It consists of two double racks, LEDR and REDR. The REDR is equipped with a cold loop (working temperature minus 15 C) to thermostat the TGC and optional cold ends. The loop pump and thermostat (refrigerator) are in the climatization fluid service station. Loop temperature regulation conforms to thermographic cavity requirements. The LEDR has a heat dump loop to cool equipment and to allow quenches. Loop temperature is coarsely regulated, fine control is to be realized at the experiment (Peltier elements). ESA

**N88-11073#** Royal Aircraft Establishment, Farnborough (England).
**COMPUTATIONAL FLUID DYNAMICS IN THE UNITED KINGDOM**
M. G. Hall and S. P. Fiddes Apr. 1987 16 p Presented at the 8th AIAA Computational Fluid Dynamics Conference, Honolulu, Hawaii, 9-11 Jun. 1987 Previously announced in IAA as A87-42081
(RAE-TM-AERO-2098; AIAA-Paper-87-1132-CP; BR102723; ETN-87-90956) Copyright Avail: NTIS HC A03/MF A01

Schemes for solving the Euler equations, based on finite volume cell-vertex methods; and a block-structured (multiblock) grid generation technique are described. Application of the grid generation scheme, with a Euler solver, to the calculation of the transonic flow past a wing-body-canard configuration, and application of viscous-inviscid interaction techniques to the design of a fan rotor are outlined. ESA

**N88-11074#** Lanchester Polytechnic, Coventry (England). Dept. of Mathematics.
**SHEARING FLOW OVER STOKES WAVE. PART ONE: GENERAL THEORY**
S. G. Sajjadi Apr. 1987 84 p
(ETN-87-90957) Avail: NTIS HC A05/MF A01

Normal and tangential stresses on the boundary of shearing flows bounded by Stokes wave are calculated. The theory is developed on the model of stable laminar flow, although the same theory may be applied also to examples of turbulent flow considered as pseudo-laminar and velocity profiles corresponding to the mean-velocity distribution. Curvilinear coordinates which follow the contour of the wave-train admit a linearized form of the problem whose validity requires only that the wave amplitude be small in comparison with the wavelength, even when large velocity gradients exist close to the boundary. It is shown that the stresses are disturbed as if the leeward slopes of the wave were sheltered, Jefferys (1924, 1925). For instance, the pressure distribution often has a substantial component in phase with the wave slope, just as if a wake were formed behind each wave crest. ESA

**N88-11075#** Lanchester Polytechnic, Coventry (England). Dept. of Mathematics.
**EFFECT OF VISCOSITY ON A VERTICAL CYLINDER DUE TO SURFACE WAVES**
A. J. Croft Apr. 1986 23 p
(ETN-87-90960) Avail: NTIS HC A03/MF A01

An approximate first order method of assessing the effect of viscosity on the loading on a fixed vertical surface-piercing circular cylinder due to a unidirectional train of sinusoidal surface waves is described. It is shown that the effect is negligible and is therefore in agreement of MacCamy and Fuchs (1954) who used Schlichting's theory of periodic boundary layers. ESA

**N88-11076** Oxford Univ. (England). Dept. of Engineering Science.
**THE EFFECT OF HEAT TRANSFER ON THE DISPERSION OF COLD DENSE GASES Thesis**
M. N. Tasker 1987 326 p Sponsored in cooperation with the United Kingdom Science and Engineering Research Council
(Contract MRS/2130/38)
(OUEL-1688/87; ETN-87-90974) Avail: NTIS HC A15

Scaling requirements for modeling heat transfer effects on the dispersion of cold dense gas clouds in wind tunnel tests are described. Mathematical simulations using a box type model show that convection induced mixing can significantly dilute a cold dense gas cloud assuming an entrainment coefficient of 2.5. A rig was built to measure convective entrainment rates into a 1 m deep cloud of nitrogen, having a bulk temperature of 170K, and heat fluxes of up to 1100 W/m were applied. At low heat fluxes, no convective entrainment occurs. It is concluded that convective entrainment may only affect the dispersion of a cold dense gas cloud if the gas is buoyant at ambient temperature, i.e., for gases such as methane and ammonia. ESA

**N88-11077#** Imperial Coll. of Science and Technology, London (England). Computational Fluid Dynamics Unit.
**NUMERICAL SIMULATION OF TRANSIENT TWO-PHASE FLOW**
D. Brian Spalding May 1987 56 p Presented at the Seminar on Transient Phenomena in Multiphase Flow, Dubrovnik, Yugoslavia, May 1987
(CFDU/87/4; ETN-87-90975) Avail: NTIS HC A04/MF A01

The numerical causes of inadequate simulations of transient two phase flow are discussed. Results of numerical computations, mainly concerned with Kelvin-Helmholtz and Rayleigh-Taylor instabilities are considered. One-dimensional analyses are described. Comparisons with experiment suggest that the actual occurrence of the postulated one-dimensional phenomena may be rather rare. ESA

**N88-11078#** Imperial Coll. of Science and Technology, London (England). Computational Fluid Dynamics Unit.
**COMPUTER MODELING OF TWO-PHASE FLOW**
S. M. Farwagi Oct. 1986 89 p
(CFDU/87/5; ETN-87-90976) Avail: NTIS HC A05/MF A01

The accelerating flow of a lighter continuous phase through a heavier one is considered. Small nonuniformities grow into large ones due to the Rayleigh-Taylor instability. An experiment exemplifying the large bubble formation due to Rayleigh-Taylor instability was performed and simulated using the PHOENICS 84 computer code. The same numerical procedure was applied to the two-phase flow in a gun barrel. It shows that the acceleration provided by the movement of the projectile can cause initial nonuniformities to grow with time. ESA

**N88-11079#** Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
**NUMERICAL SIMULATION OF TOLLMIEN-SCHLICHTING WAVES BY USE OF A MODIFIED VORTEX PARTICLE-IN-CELL METHOD**
Maozhang Chen and P. Bradshaw Jan. 1985 32 p
(IC-Aero-85-02; ISSN-0308-7247; ETN-87-90977) Avail: NTIS HC A03/MF A01

Tollmien-Schlichting (TS) wave motion was numerically simulated by a modified vortex-particle-in-cell method, in which a relative vorticity strength concept is introduced to define a continuous vorticity for better simulation of TS waves. The method is based on the exact Navier-Stokes equation for the disturbance, rather than its linearized version: therefore it may be used, in principle, to simulate the whole laminar-turbulent transition process from the initial unstability in the final breakdown. In the small disturbance region, the predicted wave velocity of TS waves corresponds to the eigenfunction of the Orr-Sommerfeld equation used to specify the initial disturbance distribution. ESA

**N88-11080#** Rolls-Royce Ltd., Derby (England).
**BOUNDARY LAYER PROFILE INVESTIGATIONS DOWNSTREAM OF AN AERO-ENGINE INTAKE ANTI-ICING AIR EXHAUST SLOT**
S. J. Downs and E. H. James (Loughborough Univ. of Technology, England ) 31 May 1987 8 p Presented at the 32nd ASME International Gas Turbine Conference and Exhibition, Anaheim, Calif., 31 May - 4 Jun. 1987
(PNR90378; ETN-87-90994) Copyright Avail: NTIS HC A02/MF A01

The boundary layer profile downstream of the anti-icing air exhaust slot of a two-dimensional aeroengine inlet section was investigated by a pitot rake. Results for a range of inlet engine airflows with and without exhaust anti-icing air introduced are presented. The boundary layer is found to be turbulent as expected owing to the presence upstream in the wind tunnel of a fixed water spray grid which may be used to simulate engine operation in clouds. Injection of anti-icing air produces a sublayer downstream of the anti-icing air exhaust plane. Three methods of deriving boundary layer thickness from the experimental data were used and theoretical values determined. Experimental measurements confirm theoretical trends. ESA

**N88-11081#** Rolls-Royce Ltd., Derby (England). Advanced Research Lab.

**OPTICAL FLOW DIAGNOSTIC MEASUREMENTS IN TURBO-MACHINERY**

D. G. Jones and R. J. Parker 1 Jun. 1987 13 p Presented at the 8th ISABE Conference, Cincinnati, Ohio, 15-19 Jun. 1987 Previously announced in IAA as A87-46245 Sponsored by the United Kingdom Ministry of Defense Procurement Executive

(PNR90396; ETN-87-90999) Copyright Avail: NTIS HC A03/MF A01

Flow measurements within the passages of rotating model fans was measured using laser holographic flow visualization and laser transit anemometry. The complementary nature of the two techniques uses the ability of holography to provide a diagnostic identification in three dimensions of main features of the flow and the ability of laser anemometry to provide quantitative measurements of the flow velocity at selected spatial locations. It is shown how the optical techniques, when suitably designed and ruggedized for a hostile environment, provide quantitative information of the intrapassage flows for a sequence of tests on wide chord fan blades, which aided the validation of their design intent. ESA

**N88-11082#** Rolls-Royce Ltd., Derby (England). Theoretical Science Group.

**COMPARISON BETWEEN NUMERICAL SOLUTIONS AND MEASUREMENTS FOR A HIGH SPEED TURBINE BLADE**

J. W. Chew and N. T. Birch 1 Sep. 1987 9 p Presented at the I Mech E Computers in Engine Technology International Conference on Turbomachinery, Cambridge, United Kingdom, 1-3 Sep. 1987 Sponsored by the United Kingdom Ministry of Defense Procurement Executive

(PNR90402; ETN-87-91001) Copyright Avail: NTIS HC A02/MF A01

Finite difference solutions of the Reynolds averaged Navier-Stokes equations and measurements for a high speed low-pressure turbine blade are compared. Two turbulence models are considered: an algebraic model and a one equation model which includes a treatment of laminar-turbulent transition. The comparison with experimental data includes surface pressure distribution, transition and separation locations, velocity traverses, boundary layer parameters, and total pressure loss. Accuracy of the numerical solution and adequacy of the turbulence models are investigated. The overall accuracy of the predictions is most severely limited by transition modeling. ESA

**N88-11083#** Rolls-Royce Ltd., Derby (England).

**JET IMPINGEMENT HEAT TRANSFER: A LITERATURE STUDY**

S. J. Downs and E. H. James 1 Sep. 1987 12 p Submitted for publication

(PNR90404; ETN-87-91002) Copyright Avail: NTIS HC A03/MF A01

Heat transfer characteristics of round, impinging jets were reviewed. Slot nozzles and nonimpinging jets are mentioned. Experimentally determined heat transfer coefficients are higher than theoretical predictions, and results vary very widely, due to the many potential error sources. ESA

**N88-11084#** Rolls-Royce Ltd., Derby (England). Advanced Research Lab.

**THE GENERATION OF NEARLY ISOTROPIC TURBULENCE BY MEANS OF GRIDS**

P. E. Roach 1 Jun. 1987 12 p Repr. from International Journal of Heat and Fluid Flow (United Kingdom), vol. 8, no. 2, Jun. 1987 p 82-92 Sponsored by the United Kingdom Ministry of Defense

(PNR90411; ETN-87-91004) Copyright Avail: NTIS HC A03/MF A01

Simple rules for the design of isotropic turbulence generators in an airflow installation are given. Pressure losses, turbulence intensities, spectra, correlation functions, and length scales are examined. Results are found to agree well with published data. ESA

**N88-11085#** Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).

**LARGE SCALE STRUCTURES IN TURBULENT PIPE FLOW**

Michael Sieber and E.-A. Mueller, ed. 1987 99 p In GERMAN; ENGLISH summary

(MPIS-Mitt-83-1987; ISSN-0374-1257; ETN-87-91043) Avail: NTIS HC A05/MF A01

A fully developed turbulent pipe flow was investigated at Reynolds numbers 28,500 and 36,000 as to coherent structures and fractal dimensions. The wall pressure and velocity fluctuations in the direction of the flow were measured simultaneously. Conditional samples of the velocity fluctuations based on characteristic pressure events show most pronounced structures near the wall. Less pronounced structures are observed throughout the whole cross section of the pipe. In the streamwise direction these structures can be followed over distances of at least 30 pipe radii. The convection velocity changes with distance from the wall proportional to the mean velocity. Using the time-lag method proposed by Takens (1981) the phase space was reconstructed out of the measured time series. The evaluation of a correlation dimension according to Grassberger and Procaccia (1983) for this phase space suggests no existence of a dimension (CH76)10. ESA

**N88-11086#** Technische Hochschule, Darmstadt (West Germany). Fachbereich Mathematik.

**CHARACTERISTICS AND BOUNDARY ELEMENTS FOR THREE DIMENSIONAL NONSTATIONARY NAVIER STOKES FLOWS**

Friedrich-Karl Hebeker Apr. 1987 9 p Sponsored by Deutschen Forschungsgemeinschaft

(Preprint-1051; ETN-87-91046) Avail: NTIS HC A02/MF A01

A numerical approach based on the boundary element method to compute nonstationary incompressible Navier Stokes flows in a three dimensional container is described. Asymptotic error estimates are presented as well as numerical examples. The secondary vortex flow in a spherical tank is computed. ESA

**N88-11087*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**PERSONAL COMPUTER (PC) BASED IMAGE PROCESSING APPLIED TO FLUID MECHANICS**

Y.-C. Cho and B. G. McLachlan Oct. 1987 8 p Presented at the SPIE 31st International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16-21 Aug. 1987

(NASA-TM-100024; A-87329; NAS 1.15:100024) Avail: NTIS HC A02/MF A01 CSCL 20D

A PC based image processing system was employed to determine the instantaneous velocity field of a two-dimensional unsteady flow. The flow was visualized using a suspension of seeding particles in water, and a laser sheet for illumination. With a finite time exposure, the particle motion was captured on a photograph as a pattern of streaks. The streak pattern was digitized and processed using various imaging operations, including contrast manipulation, noise cleaning, filtering, statistical differencing, and thresholding. Information concerning the velocity was extracted from the enhanced image by measuring the length and orientation

of the individual streaks. The fluid velocities deduced from the randomly distributed particle streaks were interpolated to obtain velocities at uniform grid points. For the interpolation a simple convolution technique with an adaptive Gaussian window was used. The results are compared with a numerical prediction by a Navier-Stokes computation. Author

**N88-11088*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**IMPACT OF TURBULENCE MODELING ON NUMERICAL ACCURACY AND EFFICIENCY OF COMPRESSIBLE FLOW SIMULATIONS**
Thomas J. Coakley Sep. 1986 9 p
(NASA-TM-88333; A-86326; NAS 1.15:88333) Avail: NTIS HC A02/MF A01 CSCL 20D

Discussed is the numerical implementation of turbulence models used in viscous compressible flow simulations and their performance described with respect to numerical accuracy, efficiency and stability. The basic approach utilizes the Reynolds-averaged compressible Navier-Stokes equations in which the Reynolds stresses and heat fluxes are mathematically modeled by suitable turbulence models. The turbulence models investigated include zero-, one-, and two-equation eddy viscosity models. The flow fields investigated include theoretical and supersonic flows about two-dimensional and axisymmetric bodies. Discussions concerning the numerical implementation of models include differencing procedures and boundary conditions used to assume numerical stability and accuracy. Numerical performance is also evaluated by comparing computations with experimental results. Author

**N88-11089*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**COMPUTATION OF TRANSONIC SEPARATED WING FLOWS USING AN EULER/NAVIER-STOKES ZONAL APPROACH**
Uenver Kaynak, Terry L. Holst, and Brian J. Cantwell (Stanford Univ., Calif.) Jul. 1986 152 p
(NASA-TM-88311; A-86271; NAS 1.15:88311) Avail: NTIS HC A08/MF A01 CSCL 20D

A computer program called Transonic Navier Stokes (TNS) has been developed which solves the Euler/Navier-Stokes equations around wings using a zonal grid approach. In the present zonal scheme, the physical domain of interest is divided into several subdomains called zones and the governing equations are solved interactively. The advantages of the Zonal Grid approach are as follows: (1) the grid for any subdomain can be generated easily; (2) grids can be, in a sense, adapted to the solution; (3) different equation sets can be used in different zones; and, (4) this approach allows for a convenient data base organization scheme. Using this code, separated flows on a NACA 0012 section wing and on the NASA Ames WING C have been computed. First, the effects of turbulence and artificial dissipation models incorporated into the code are assessed by comparing the TNS results with other CFD codes and experiments. Then a series of flow cases is described where data are available. The computed results, including cases with shock-induced separation, are in good agreement with experimental data. Finally, some futuristic cases are presented to demonstrate the abilities of the code for massively separated cases which do not have experimental data. Author

**N88-10833*#** New Jersey Inst. of Tech., Newark.
**RADIATIVE AND FREE-CONVECTIVE HEAT TRANSFER FROM A FINITE HORIZONTAL PLATE INSIDE AN ENCLOSURE**
Peter Hrycak and D. J. Sandman *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 42-60 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-10857*#** North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering.
**TRANSIENT MODELING OF THE THERMOHYDRAULIC BEHAVIOR OF HIGH TEMPERATURE HEAT PIPES FOR SPACE REACTOR APPLICATIONS**
Michael L. Hall and Joseph M. Doster *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 313-330 Sponsored in part by DOE (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-10858*#** Hughes Aircraft Co., Fullerton, Calif.
**APPLICATIONS OF HEAT PIPES TO COOL PWBS AND HYBRID MICROCIRCUITS**
K. S. Sekhon *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 331-340 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-10997#** Joint Publications Research Service, Arlington, Va.
**INSTABILITY OF STEADY FLOW WITH CONSTANT VORTICITY IN VESSELS WITH ELLIPTICAL CROSS-SECTION Abstract Only**
V. A. Vladimirov and D. G. Vostretsov *In its* USSR Report: Engineering and Equipment 4 May 1987 p 105 Transl. into ENGLISH from Prikladnaya Matematika i Mekhanika (Moscow, USSR), v. 50, no. 3, Mar. 1986 p 369-377 Original language document was announced in IAA as A87-10428 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

**N88-10998#** Joint Publications Research Service, Arlington, Va.
**EFFECT OF DISSIPATION ON PROPAGATION OF SPHERICAL DETONATION SHOCK WAVE Abstract Only**
V. N. Likhachev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 106 Transl. into ENGLISH from Prikladnaya Matematika i Mekhanika (Moscow, USSR), v. 50, no. 3, Mar. 1986 p 384-393 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

**N88-10999#** Joint Publications Research Service, Arlington, Va.
**REFRACTION OF SHEAR WAVE INTO NONLINEARLY ELASTIC OR ELASTOPLASTIC HALF-SPACE Abstract Only**
A. G. Bykovtsev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 106 Transl. into ENGLISH from Prikladnaya Matematica i Mekhanika (Moscow, USSR), v. 50, no. 3, Mar. 1986 p 490-497 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

**N88-11148*#** Avco-Everett Research Lab., Mass.
**IMPROVED NUMERICAL METHODS FOR TURBULENT VISCOUS RECIRCULATING FLOWS Progress Report**
A. Turan *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 87-88 (For primary document see N88-11140 02-39)
(Contract NAS3-24351)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11149*#** General Motors Corp., Detroit, Mich. Gas Turbine Div.
**AEROTHERMAL MODELING PROGRAM, PHASE 2**
H. C. Mongia, S. V. Patankar, S. N. B. Murthy, J. P. Sullivan, and G. S. Samuelsen (California Univ., Irvine.) *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 89-108 (For primary document see N88-11140 02-39)
(Contract NAS3-24350)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11150*#** United Technologies Research Center, East Hartford, Conn.
**FUEL-INJECTOR/AIR-SWIRL CHARACTERIZATION**

J. B. McVey, J. B. Kennedy, and J. C. Bennett (Connecticut Univ., Storrs.) *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 109-117 (For primary document see N88-11140 02-39)
(Contract NAS3-24352)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11151*#** Minnesota Univ., Minneapolis.
**EFFICIENT NUMERICAL TECHNIQUES FOR COMPLEX FLUID FLOWS**
Suhas V. Patankar *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 119-120 (For primary document see N88-11140 02-39)
(Contract NAS3-596)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11153*#** Garrett Turbine Engine Co., Phoenix, Ariz.
**DILUTION JET MIXING PROGRAM, PHASE 3**
R. Srinivasan, G. Myers, and C. White *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 127-132 (For primary document see N88-11140 02-39)
(Contract NAS3-22110)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11154*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ON THE MIXING OF A ROW OF JETS WITH A CONFINED CROSSFLOW**
J. D. Holdeman *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 133-138 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11155*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**HEAT TRANSFER IN A REAL ENGINE ENVIRONMENT**
Herbert J. Gladden *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 139-150 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11156*#** General Motors Corp., Indianapolis, Ind. Gas Turbine Div.
**FILM COOLING HEAT TRANSFER ON A TURBINE AIRFOIL**
Larry D. Hylton *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 151-159 (For primary document see N88-11140 02-39)
(Contract NAS3-24619)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11157*#** Tennessee Univ. Space Inst., Tullahoma.
**FLOW FIELD MEASUREMENTS IN A 90 DEGREE TURNING DUCT**
Roger A. Crawford and Carroll E. Peters *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 161-164 (For primary document see N88-11140 02-39)
(Grant NAG3-617)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11158*#** United Technologies Research Center, East Hartford, Conn.
**MEASUREMENT OF AIRFOIL HEAT TRANSFER COEFFICIENTS ON A TURBINE STAGE**
Robert P. Dring, Michael F. Blair, and H. David Joslyn *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 165-173 (For primary document see N88-11140 02-39)
(Contract NAS3-23717)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11159*#** Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
**HEAT TRANSFER IN THE TIP REGION OF A ROTOR BLADE SIMULATOR**
D. E. Metzger, M. K. Chyu, and H. K. Moon *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 175-186 (For primary document see N88-11140 02-39)
(Grant NAG3-623)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11160*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**COOLANT PASSAGE HEAT TRANSFER WITH ROTATION**
T. J. Hajek and A. W. Higgins *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 187-201 (For primary document see N88-11140 02-39)
(Contract NAS3-23691)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11161*#** Stanford Univ., Calif. Thermosciences Div.
**HEAT TRANSFER WITH VERY HIGH FREE STREAM TURBULENCE**
Robert J. Moffat and Paul K. Maciejewski *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 203-215 (For primary document see N88-11140 02-39)
(Grant NAG3-522)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11162*#** Minnesota Univ., Minneapolis.
**PREDICTION OF TURBINE BLADE HEAT TRANSFER**
Suhas V. Patankar *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 217-219 (For primary document see N88-11140 02-39)
(Grant NAG3-579)
Avail: NTIS HC A19/MF A01 CSCL 20D

**N88-11163*#** Scientific Research Associates, Inc., Glastonbury, Conn.
**FLOW IN A MODEL TURBINE STATOR**
R. C. Buggeln, S. J. Shamroth, and W. R. Briley *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 221-226 (For primary document see N88-11140 02-39)
(Contract NAS3-24358)
Avail: NTIS HC A19/MF A01 CSCL 20D

# 35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

**N88-11090#** Lawrence Livermore National Lab., Calif.
**EVALUATING AND TESTING THERMOGRAPHIC PHOSPHORS FOR TURBINE-ENGINE TEMPERATURE MEASUREMENTS**
B. W. Noel, S. W. Allison, D. L. Beshears, M. R. Cates, H. M. Borella, L. A. Franks, C. E. Iverson, S. S. Lutz, B. R. Marshall, and M. B. Thomas (EG and G Energy Measurements, Inc., Las Vegas, Nev.) et al. 1987 18 p Presented at the 23rd AIAA/SAE/ASME/ASEE Joint Propulsion Conference, San Diego, Calif., 29 Jun. 1987 Previously announced in IAA as A87-45188 Prepared in cooperation with Virginia Univ., Charlottesville
(Contract W-7405-eng-36)
(DE87-011772; LA-UR-87-2017; CONF-8706157-1) Avail: NTIS HC A03/MF A01

A technique developed earlier for measuring the temperature of inaccessible surfaces in low-temperature rotating machines is being adapted to measure the temperature of surfaces at the higher temperatures and in the erosive environment inside operating turbine engines. The method uses the temperature dependence of the characteristic decay time of the laser-induced-fluorescence

of thermographic phosphors to measure the temperature. This paper summarizes recent work in four areas: phosphor characterization and calibration, instrumentation development, bonding, and field tests. By using improved instrumentation and data-analysis techniques, calibration curves for several phosphors are measured with greater accuracy and extended to higher temperatures than before. Phosphors are evaluated that were attached to sample surfaces by high-temperature bonding materials, electron-beam deposition, flame spraying, and plasma spraying. A burner rig test was performed on some phosphor-coated samples and the instrumentation required for an upcoming spin-pit test was designed, built, and calibrated. DOE

**N88-11091#** Lawrence Livermore National Lab., Calif. Electronic Engineering Dept.
**PROGRAMMABLE 10 MHz OPTICAL FIDUCIAL SYSTEM FOR HYDRODIAGNOSTIC CAMERAS**
Tony Huen Jul. 1987 10 p Presented at the 31st SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16-21 Aug. 1987
(Contract W-7405-eng-48)
(DE87-013223; UCRL-97094; CONF-8708110-2) Avail: NTIS HC A02/MF A01

A solid state light control system was designed and fabricated for use with hydrodiagnostic streak cameras of the electro-optic type. With its use, the film containing the streak images will have on it two time scales simultaneously exposed with the signal. This allows timing and cross timing. The latter is achieved with exposure modulation marking onto the time tick marks. The purpose of using two time scales will be discussed. The design is based on a microcomputer, resulting in a compact and easy to use instrument. The light source is a small red LED. Time marking can be programmed in steps of 0.1 microsec, with a range of 255 steps. The time accuracy is based on a precision 100 MHz quartz crystal, giving a divided down 10 MHz system frequency. The light is guided by two small 100 micron diameter optical fibers, which facilitates light coupling onto the input slit of an electro-optic streak camera. Three distinct groups of exposure modulation of the time tick marks can be independently set anywhere onto the streak duration. This system has been successfully used in Fabry-Perot laser velocimeters for over 4 years. The microcomputer control section is also being used in providing optical fids to mechanical rotor cameras. DOE

**N88-11092#** National Bureau of Standards, Washington, D.C.
**OPTICAL POWER LINE VOLTAGE AND CURRENT MEASUREMENT SYSTEMS. VOLUME 1: LIMITS TO THE PRECISION OF ELECTRO-OPTIC AND MAGNETO-OPTIC SENSORS Final Report**
G. W. Day, P. D. Hale, M. Deeter, T. E. Milner, D. Conrad, and S. M. Etzel Sep. 1987 122 p Prepared in cooperation with Electric Power Research Inst., Palo Alto, Calif.
(EPRI Proj. 2748)
(DE87-014558; EPRI-EL-5431-Vol-1) Avail: NTIS HC A06/MF A01

This study began with a central question, What precision can be achieved with an electro-optic voltage sensor or a magneto-optic current sensor. The answer has been pursued in numerous ways - through an investigation of the basic properties of materials and components (both as reported in the literature and new data generated in our laboratory), through attempts to demonstrate the feasibility of overcoming certain limitations in the properties of components, through analysis of some fundamental limitations, through the proposal of new or refined designs, and through discussions with numerous other investigators. It was concluded that ease of obtaining high precision (in a power systems context) is not included among the advantages of using optical sensors for measurement of electromagnetic quantities. The principal difficulty was that sensors have to maintain their calibration over broad temperature ranges (at least 100°C) without the possibility of temperature stabilization. Specifically, using relatively standard approaches and an appropriate definition of precision, a precision not better than about + or - 1% can be expected. Achieving this level of precision will require wise choices of materials, components, and design; numerous suggestions are offered. DOE

**N88-11093#** Brookhaven National Lab., Upton, N. Y. Center for Structural Biology.
**MULTILAYER MONOCHROMATORS FOR NEUTRON SPECTROMETERS**
A. M. Saxena and B. P. Schoenborn 1987 4 p Presented at the Neutron Scattering Symposium on Advances and Applications, Sydney, Australia, 8 Aug. 1987
(Contract DE-AC02-76CH-00016; Grant NSF PCM-84-00868)
(DE87-014291; BNL-40084; CONF-8708117-2) Avail: NTIS HC A02/MF A01

Multilayer devices have proved to be useful in improving the characteristics of small angle neutron spectrometers. Multilayer monochromators have been fabricated, with d-spacings in the 57 to 200 A range, that have reflectivities greater than 0.95. Multilayer polarizers made of Fe-Ge have similar d-spacings and reflectivities, and polarize the neutron beam with an efficiency approaching unity. It has been shown that the use of neutron guidetubes made of multilayer supermirrors will result in a higher neutron flux at the sample. Present efforts in the fabrication of multilayers are directed towards the following: (1) decreasing the d-spacing while maintaining a high reflectivity, (2) depositing multiple d-spacing monochromators for optimizing the performance of a spectrometer, (3) design and development of supermirror guidetubes. Deposition of such devices requires a precise control on the thickness of each film, with the possibility of changing thicknesses in a predetermined manner. Comparison of theoretical calculations with the diffraction characteristics of multilayers has shown that actual multilayers have significant thickness disorder, which results in a degradation of reflection properties. DOE

**N88-11094#** Kansas State Univ., Manhattan.
**THE DEVELOPMENT OF A NEW AND NOVEL HADAMARD TRANSFORM INFRARED SPECTROMETER FOR ANALYTICAL CHEMISTRY Progress Report, 15 May 1985 - 1987**
1987 11 p
(Contract DE-FG02-85ER-13347)
(DE87-014804; DOE/ER-13347/1) Avail: NTIS HC A03/MF A01

This report summarizes the research accomplished under this grant in the areas of: VO2 Hadamard masks; Hadamard transform spectrometer construction; computer software for Hadamard to Fourier transformation; and photoacoustic spectrometry. A listing of papers and chapters resulting from this research is also provided. DOE

**N88-11095#** Bremer Inst. fuer Angewandte Strahltechnik, Bremen (West Germany).
**DEVELOPMENT AND TESTING OF A SYSTEM FOR THE PARTIALLY AUTOMATED EVALUATION OF HOLOGRAPHIC INTERFEROGRAMS IN THE EXPERIMENTAL STRESS ANALYSIS OF REACTOR COMPONENTS Final Report [ENTWICKLUNG UND ERPROBUNG EINES SYSTEMS ZUR TEILAUTOMATISIERTEN AUSWERTUNG HOLOGRAFISCHER INTERFEROGRAMME BEI DER EXPERIMENTELLEN SPANNUNGSANALYSE AN REAKTORBAUTEILEN]**
W. Jueptner, H. Kreitlow, Th. Kreis, P. Steinlein, F. Hock, and B. Garbe Dec. 1984 80 p In GERMAN Sponsored by the Bundesministerium fuer Forschung und Technologie, Federal Rep. of Germany
(ETN-87-90574) Avail: NTIS HC A05/MF A01

The deformations at reactor component surfaces were studied by holographic interferograms in order to determine the stress intensities in the interior of the components. The deformation fields at the side surfaces of tensile test specimens with varying internal cracks were calculated by the finite element method. From the known surface deformations the stresses in the interior were calculated with good accuracy as long as the error of the deformation measurement remains less than 5%. A method to deduce the length of the crack by iteration of the measured surface

deformations was developed. An automated recording and evaluation system for interference patterns using image processing according to the phase-shifted reference wave method provides an accuracy better than 5%. ESA

**N88-11096#** Institut Franco-Allemand de Recherches, St. Louis (France).
**ULTRAFAST HOLOGRAPHY USING OPTICAL FIBERS Final Report [HOLOGRAPHIE ULTRA-RAPIDE UTILISANT DES FIBRES OPTIQUES]**
F. Albe 14 Jan. 1986 64 p In FRENCH
(Contract DRET-83-1160)
(ISL-R-101/86; ETN-87-90634) Avail: NTIS HC A04/MF A01

Optical fibers were used to produce diffused light holograms with continuous and pulsed lasers. The technique is intended for industrial nondestructive tests. The applications studied include the utilization of fibers to illuminate only and the use of additional fibers to convey the image light coming from the object to the photographic plate (endoscope). A large number of holograms was obtained using different experimental set-ups. The experimental conditions are discussed and the resulting holograms are presented. ESA

**N88-11097#** Institut Franco-Allemand de Recherches, St. Louis (France).
**IMPROVING COHERENT VISUALIZATION BY MEANS OF FILM OPTICAL FILTERING [AMELIORATION DES VISUALISATIONS COHERENTES PAR FILTRAGE OPTIQUE DES CLICHES]**
H. Royer 16 Jun. 1986 24 p In FRENCH
(ISL-R-116/86; ETN-87-90639) Avail: NTIS HC A02/MF A01

An optical filtering facility allows the selective elimination of diffraction bands without modification of the boundary layer. The technique is employed to visualize the boundary layer around a high velocity projectile. When using a laser source, the intensive diffraction in the boundary layer zone masks it. The technique should facilitate all ultrafast visualizations, and shadowgraphs in particular. ESA

**N88-11098#** Rolls-Royce Ltd., Derby (England). Advanced Research Lab.
**THE USE OF HOLOGRAPHIC INTERFEROMETRY FOR TURBOMACHINERY FAN EVALUATION DURING ROTATING TESTS**
R. J. Parker and D. G. Jones 31 May 1987 12 p Presented at the 32nd ASME International Gas Turbine Conference and Exhibition, Anaheim, Calif., 31 May - 4 Jun. 1987 Sponsored by the United Kingdom Ministry of Defense
(PNR90390; ETN-87-90995) Copyright Avail: NTIS HC A03/MF A01

Holography was used to investigate aerodynamic and mechanical behavior of rotating fans. Holographic flow visualization provides clear, three-dimensional images of the transonic flow region between the fan blades. Flow features such as shocks, shock/boundary layer interaction, and overtip leakage vortices can be observed and measured. Holograms taken through an optical derotator allow vibration modes of the rotating fan to be mapped during resonance or flutter. Examples of the use of both techniques at rotational speeds up to and over 10,000 rpm are given. Holography is used to verify and improve numerical modeling of fan behavior and in evaluating the achievement of design intent. ESA

**N88-11099** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fuer Extraterrestrische Physik.
**MULTILAYERED FOILS AS RADIATION ENTRANCE WINDOWS AND SPECTRAL FILTERS FOR IMAGE CONVERTERS IN THE ULTRASOFT X-RAY WAVELENGTH REGION**
K.-H. Stephan, H. Braeuninger, H. Kaase, H. J. Maier, W. Schoene, and H. Wilski (Hoechst A.G., Wiesbaden, West Germany ) May 1987 19 p Presented at the Society of Photo-Optical Instrumentation Engineers, Berlin, Fed. Republic of Germany, Dec. 1986 Original contains color illustrations
(MPE-Preprint-90; ETN-87-91035) Copyright Avail: Issuing Activity

Ultrathin multilayered films to serve as radiation entrance windows and spectral filters in satellite-borne position sensitive proportional counters (PSPC) for imaging ultrasoft X-rays from celestial sources in the wavelength region 0.6 to 10 nm were developed. Suppression at the carbon-K alpha-edge corresponding to a transmission grade of 20% is achieved. Windows with enhanced transmissions and better spatial uniformity were operated successfully in a PSPC engineering model. The suppression of UV-radiation is not sufficient since it was impossible to deposite carbon layers thicker than 20 microg/sq cm. However this problem was solved. ESA

**N88-11100*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**REDUCTION OF TEMPERATURE RISE IN HIGH-SPEED PHOTOGRAPHY**
Howard A. Slater Aug. 1987 18 p Presented at the 31st International Technical Symposium on Optical and Optoelectronic Applied Sciences and Engineering, San Diego, Calif., 16-21 Aug. 1987; sponsored by the Society of Photo-Optical Instrumentation Engineers
(NASA-TM-100222; E-3666; NAS 1.15:100222) Avail: NTIS HC A03/MF A01 CSCL 14E

Information is provided on filtration with glass and infrared absorbing and reflecting filters. Glass and infrared filtration is a simple and effective method to reduce the radiation heat transfer associated with continuous high intensity tungsten lamps. The results of a filtration experiment are explained. The figures provide starting points for quantifying the effectiveness of various filters and associated light intensities. The combination of a spectrally selective reflector (hot or cold mirror) based on multilayer thin film principles and heat absorbing or infrared opaque glass results in the maximum reduction in temperature rise with a minimum of incident light loss. Use is recommended of a voltage regulator to further control temperature rise and incident light values. Author

**N88-11101*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**A 1987 PROGRESS REPORT OF MANUFACTURING TECHNIQUES FOR GRAVITY PROBE B GYROSCOPE ROTORS**
Roy A. Taylor, Ed White, and William J. Reed Sep. 1987 32 p
(NASA-TM-100312; NAS 1.15:100312) Avail: NTIS HC A03/MF A01 CSCL 14B

The significant improvements in the manufacture of Gravity Probe B gyroscope rotors developed since the publication of the last report on this project are presented. The improvements include the polishing machine structure, rough laps, finishing/polishing laps, lapping procedure, measurement techniques, and a summary of the manufacturing status. These six areas represent significant improvements in the manufacture of the gyroscope rotors to meet flight requirements. Author

**N88-10831*#** Spar Aerospace Ltd., Ste-Anne-de-Bellevue (Quebec).
**MONITORED BACKGROUND RADIOMETER**
C. Ruel, M. Larouche, and M. Donato *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 15-26 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10835*#** Boeing Co., Seattle, Wash.
**USE OF A 35mm CAMERA FOR REMOTE SURFACE CLEANLINESS VERIFICATION Abstract Only**
E. R. Crutcher *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 63 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-10856*#** Spar Aerospace Ltd., Ste-Anne-de-Bellevue (Quebec).
**EVALUATION OF THE INFRARED TEST METHOD FOR THE OLYMPUS THERMAL BALANCE TESTS**
M. Donato, D. StPierre, J. Green, and M. Reeves *In* NASA-Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 312 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-11141*#** Pratt and Whitney Aircraft, West Palm Beach, Fla. Engineering Div.
**FURTHER DEVELOPMENT OF THE DYNAMIC GAS TEMPERATURE MEASUREMENT SYSTEM**
D. L. Elmore, W. W. Robinson, and W. B. Watkins *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 37-43 (For primary document see N88-11140 02-39)
(Contract NAS3-24228)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-11142*#** United Technologies Research Center, East Hartford, Conn.
**THE DEVELOPMENT OF A HIGH TEMPERATURE STATIC STRAIN GAGE SYSTEM**
Charles O. Hulse, Richard S. Bailey, and Howard P. Grant (Pratt and Whitney Aircraft, East Hartford, Conn.) *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 45-49 (For primary document see N88-11140 02-39)
(Contract NAS3-23722)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-11143*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**DEVELOPMENT OF HEAT FLUX SENSORS FOR TURBINE AIRFOILS**
William H. Atkinson, Marcia A. Cyr, and Richard R. Strange *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 51-58 (For primary document see N88-11140 02-39)
(Contract NAS3-23529)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-11144*#** Northwestern Univ., Evanston, Ill.
**ELEVATED TEMPERATURE STRAIN GAGES**
J. O. Brittain, D. Geslin, and J. F. Lei *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 59-65 (For primary document see N88-11140 02-39)
(Grant NAG3-501)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-11146*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**THE LEWIS STRAIN GAUGE LABORATORY: STATUS AND PLANS**
Howard F. Hobart and Herbert A. Will *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 77-79 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-11147*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**CORRELATION OF VELOCITY AND VELOCITY-DENSITY TURBULENCE IN THE EXHAUST OF AN ATMOSPHERIC BURNER**
Gustave C. Fralick *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 81-85 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 14B

**N88-11167*#** Akron Univ., Ohio.
**EXPERIMENTAL DETERMINATION OF FLOW POTENTIAL SURFACES SUPPORTING A MULTIAXIAL FORMULATION OF VISCOPLASTICITY**
J. R. Ellis and D. N. Robinson *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 259-269 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 14B

# 36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

**N88-11102#** California Univ., Berkeley. Lawrence Berkeley Lab. Accelerator and Fusion Research Div.
**BRIGHTNESS AND COHERENCE OF RADIATION FROM UNDULATORS AND HIGH-GAIN FREE ELECTRON LASERS**
Kwang-Je Kim Mar. 1987 7 p Presented at the Particle Accelerator Conference, Washington, D.C., 16-19 Mar. 1987
(Contract DE-AC03-76SF-00098)
(DE87-011093; LBL-22236; CONF-870302-203) Avail: NTIS HC A02/MF A01

The purpose of this paper is to review the radiation characteristics of undulators and high-gain free electron lasers (FELs). The topics covered are: a phase-space method in wave optics and synchrotron radiation, coherence from the phase-space point of view, discussions of undulator performances in next-generation synchrotron radiation facility and the characteristics of the high-gain FELs and their performances. DOE

**N88-11103#** Los Alamos National Lab., N. Mex.
**SIDEBAND SUPPRESSION BY AN INTRACAVITY OPTICAL FILTER IN THE LOS ALAMOS FREE-ELECTRON LASER OSCILLATOR**
John C. Goldstein, Brian E. Newnam, and Roger W. Warren 1987 21 p Presented at the 9th International Free-electron Laser Conference, Williamsburg, Va., 14-18 Sep. 1987
(Contract W-7405-eng-36)
(DE87-011740; LA-UR-87-2147; CONF-8709110-1) Avail: NTIS HC A03/MF A01

Experiments at the Los Alamos free-electron laser oscillator were performed with a 7.35% (delta gamma /sub r//delta gamma /sub r/) tapered wiggler. Multilayer dielectric mirrors with wavelength-dependent reflectivity and phase shift functions were used to provide high reflectivity at the fundamental wavelength but to introduce losses at expected sideband wavelengths. The electron-beam energy was varied to tune the fundamental optical wavelength. Experimental measurements are compared with results of 1-d time-dependent simulations. For the particular wiggler, optics, and e-beam conditions of this experiment, spectral sidebands were reduced only with a concomitant reduction of the total optical output of the laser. DOE

**N88-11104#** Los Alamos National Lab., N. Mex.
**A HIGH-POWER RF LINEAR ACCELERATOR FOR FELs (FREE-ELECTRON LASERS)**
R. L. Sheffield and J. M. Watson 1987 5 p Presented at the 19th Fluid Dynamics, Plasma Dynamics, and Laser Conference, Honolulu, Hawaii, 8-10 Jun. 1987 Sponsored in part by Army Strategic Defense Command
(Contract W-7405-eng-36)
(DE87-011795; LA-UR-87-1242; CONF-870622-8) Avail: NTIS HC A02/MF A01

Described is the design of a high average current RF linear accelerator suitable for driving short-wavelength free-electron lasers (FEL). It is concluded that the design of a room-temperature RF linear accelerator that can meet the stringent requirements of a high-power short-wavelength FEL appears possible. The accelerator requires the use of an advanced photoelectric injector that is under development; the accelerator components, however, do not require appreciable development. At these large beam currents, low-frequency, large-bore room-temperature cavities can be highly efficient and give all specified performance with minimal risk. DOE

**N88-11105#** Lawrence Livermore National Lab., Calif.
**IR LASER EXCITATION IN MOLECULES: CHAOS AND DIFFUSIVE ENERGY GROWTH**
J. R. Ackerhalt and P. W. Milonni 1987 12 p Presented at the NATO Workshop on Atomic and Molecular Processes With Short Intense Laser Pulse, Sherbrooke, Quebec, 19-24 Jul. 1987
(Contract W-7405-eng-36)
(DE87-013147; LA-UR-87-2311; CONF-870784-1) Avail: NTIS HC A03/MF A01

After a short review of a generic vibrational model of IR multiple-photon excitation, the model is generalized to include rotations. It is shown that the combination of chaotic dynamics and rotational averaging leads to fluence-dependent absorption which removes the sensitivity of the results to model-dependent parameters. The classical rotation-vibration dynamics observed in this model correlate very well with quantum intuition based on a molecule's P, Q, and R-branch structure and on the red-shift of the vibrational absorption with excitation. The implication of these results for MPE experiments is discussed. DOE

**N88-11106#** Lawrence Livermore National Lab., Calif. Theoretical Div.
**QUANTUM-MECHANICAL ASPECTS OF CLASSICALLY CHAOTIC DRIVEN SYSTEMS**
P. W. Milonni, J. R. Ackerhalt, and M. E. Goggin 1987 8 p Presented at the International Conference on Multiphoton Processes, Boulder, Colo., 14 Jul. 1987
(Contract W-7405-eng-36)
(DE87-013152; LA-UR-87-2322; CONF-870789-1) Avail: NTIS HC A02/MF A01

Atoms and molecules in laser fields are treated as periodically driven quantum systems. It is concluded that stochastic excitation is possible in quantum systems with quasiperiodic driving. DOE

**N88-11107#** Lawrence Livermore National Lab., Calif. Physics Div.
**METHOD FOR SINGLE-SHOT MEASUREMENT OF PICOSECOND LASER PULSE-LENGTHS WITHOUT ELECTRONIC TIME DISPERSION**
George A. Kyrala 1987 15 p Presented at the 31st SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16-21 Aug. 1987
(Contract W-7405-eng-36)
(DE87-013171; LA-UR-87-2538; CONF-8708110-1) Avail: NTIS HC A03/MF A01

A two-source shear pattern recording is proposed as a method for single-shot measurement of the pulse shape from nearly monochromatic sources whose pulse lengths are shorter than their coherence times. The basis of this method relies on the assertion that if two identical electromagnetic pulses are recombined with a time delay greater than the sum of their pulse widths, the recordable spatial pattern has no fringes in it. At an arbitrary delay, translated into an actual spatial recording position, the recorded modulated intensity will sample the corresponding laser intensity at that delay time, but with a modulation due to the coherence function of the electromagnetic pulse. Two arrangements are proposed for recording the pattern. The principles, the design parameters, and the methodologies of these arrangements are presented. Resolutions of the configurations and their limitations are given as well. DOE

**N88-11108#** Columbia Univ., New York, N.Y. Dept. of Physics.
**ON THE COLLECTIVE VARIABLES DESCRIPTION OF A HIGH GAIN FREE ELECTRON LASER**
Ivan Gjaja Jun. 1987 9 p Prepared for BNL, Upton, N.Y.
(Contract DE-AC02-76CH-00016)
(DE87-013315; BNL-39971) Avail: NTIS HC A02/MF A01

It has been shown that the linearized equations describing the motion of electrons and the development of the radiation field in a free electron laser (FEL) can be conveniently studied using the collective variable approach. The advantage of this method is that the equations are greatly simplified, while the variables remain physically easily recognizable quantities. In this report two methods are used to construct the collective variables and deduce their linearized equations of motion: the Vlasov-Maxwell approach, where the distribution function f and the radiation field are linearized about equilibrium, and the many particle approach in which the linearization is performed for the dynamical variables of all the particles and the radiation field. In both cases the transverse effects and the dependence of the radiation field on spatial coordinates are included. The two approaches are equivalent. DOE

**N88-11109#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**LLE REVIEW, VOLUME 30 Quarterly Report, Jan. - Mar. 1987**
J. Delettrez, ed. 1987 59 p
(Contract DE-FC08-85DP-40200)
(DE87-014469; DOE/DP-40200/46-Vol-30) Avail: NTIS HC A04/MF A01

This volume of the LLE Review, covering the period January to March 1987, contains an improved X-ray microscopy technique for characterization of inertial fusion targets; improvements in the coefficient for inverse bremsstrahlung laser absorption; an analysis of new geometries for X-ray laser studies and the results of inertial experiments; and the National Laser Users Facility activities for this period. DOE

**N88-11110#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**LLE REVIEW Quarterly Report, Oct. - Dec. 1986**
J. Delettrez, ed. 1986 56 p
(Contract DE-FC08-85DP-40200)
(DE87-014468; DOE/DP-40200/38-Vol-29) Avail: NTIS HC A04/MF A01

This volume of the LLE Review contains an analysis of the effect of laser illumination nonuniformity on the analysis of transport experiments; a review of measurements carried out with a high-resolution XUV spectrometer; a study of shock launching in silicon crystals; measurements of thermal conductivity in dielectric thin films; and the National Laser Users Facility activities for this period. Finally, the laser activities on GDL and OMEGA are summarized. The following are highlights of the research reports contained in this issue: (1) A method has been developed to study from simulations the effect of laser illumination nonuniformity on the interpretation of the transport experiments carried out with the 24 UV beams of OMEGA. (2) A high-resolution extreme UV spectrograph was used to study relativistic and quantum electrodynamic effects in high atomic number elements, to measure conditions in the coronal plasma, and to diagnose transitions in X-ray laser research. (3) The temporal variation of lattice spacing due to shocks launched into laser-irradiated silicon crystals was studied by Bragg X-ray diffractometry with pulsed X-rays. (4) A method has been developed for measuring the thermal conductivity of dielectric materials in thin-film form. (5) A 25th beam from the output of the GDL active mirror laser system has been focused onto a target in the OMEGA chamber. DOE

**N88-11111#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**TIME-RESOLVED ABLATION MEASUREMENTS OF IMPLODING TARGETS**
L. DaSilva, J. Delettrez, R. Epstein, G. G. Gregory, P. A. Jaanimagi, and M. C. Richardson 1986 12 p Presented at the 16th Annual Anomalous Absorption Conference, Lake Luzerne, N.Y., 13 Jul. 1986
(Contract DE-FC08-85DP-40200)
(DE87-014464; DOE/DP-40200/34; CONF-8607116-3-Vugraphs) Avail: NTIS HC A03/MF A01

Time-resolved X-ray spectroscopy of multi-layer shell targets irradiated by the 24 UV-beam OMEGA laser at LLE has been used to infer the mass ablation rate during the implosion. The X-ray emission from Al and Mg signature layers imbedded in 10 microns of CH was recorded with an X-ray streak camera coupled to an elliptical crystal spectrometer. The radial position at the time of burn-through was measured directly using time-resolved X-ray imaging. The mass ablation rate calculated by this method, although confirming previous experimental measurements, continues to exceed that predicted by the hydrocode LILAC run

with a flux limiter of 0.06. Furthermore, the time evolution of the Al and Mg emission indicate a characteristic rise-time longer than that observed in non-LTE simulations. One possible explanation of these discrepancies is beam nonuniformities, the effects of which are discussed. The report consists of viewgraphs. DOE

**N88-11112#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**TIME-RESOLVED ABSORPTION MEASUREMENTS ON OMEGA**
P. A. Jaanimagi, L. DaSilva, J. Delettrez, G. G. Gregory, and M. C. Richardson 1986 16 p Presented at the 16th Annual Anomalous Absorption Conference, Lake Luzerne, N.Y., 13 Jul. 1986
(Contract DE-FC08-85DP-40200)
(DE87-014465; DOE/DP-40200/33; CONF-8607116-2-Vugraphs) Avail: NTIS HC A03/MF A01

Time-resolved measurements of the incident laser light that is scattered and/or refracted from targets irradiated by the 24 UV-beam OMEGA laser at LLE, have provided some interesting features related to time-resolved absorption. The decrease in laser absorption characteristic of irradiating a target that implodes during the laser pulse has been observed. The increase in absorption expected as the critical density surface moves from a low to a high Z material in the target has also been noted. The detailed interpretation of these results is made through comparisons with simulation using the code LILAC, as well as with streak data from time-resolved X-ray imaging and spectroscopy. In addition, time and space-resolved imaging of the scattered light yields information on laser irradiation uniformity conditions on the target. The report consists of viewgraphs. DOE

**N88-11113#** Los Alamos National Lab., N. Mex.
**DEVELOPMENT OF A HIGH-ENERGY CROWBAR FOR THE LOS ALAMOS FREE-ELECTRON LASER**
J. O. Hornkohl and M. T. Lynch 1987 13 p Presented at the 9th International Free-Electron Laser Conference, Williamsburg, Va., 14 Sep. 1987
(Contract W-7405-eng-36)
(DE87-014748; LA-UR-87-2882; CONF-8709110-2) Avail: NTIS HC A03/MF A01

A 135-kV, 2.5-micron crowbar has been developed to protect the TH2095A klystrons used on the Los Alamos free-electron laser. The klystron power supply consists of a 135-kV, 8.75-microF capacitor bank with a stored energy of about 80 kJ. The TH2095A requires that the dissipated energy in a klystron arc be limited to less than 10J. The crowbar design is based on a series stack of pressurized spark gaps immersed in an oil tank. The spark gaps are triggered by an SCR-switched high-voltage trigger transformer. Input triggers are provided by current-monitoring transformers. The following currents are sensed for input triggers: total system current, integrated system current (long pulse sensing), cathode current, and modulator-anode current. Trigger levels are set to about 150% of nominal current levels. Unique features of this design are its modulator-anode trigger, noise immunity, and ability to print out the energy dissipated in the klystron arc. Typical operation of this system limits the energy dissipated in an arc to less than 2J. Described are the original design requirements, mechanical layout and fabrication, main trigger circuit design, modulator-anode trigger design, noise immunity circuit, integrated enery monitor, diagnostics, and recent developments. Performance data are also included. DOE

**N88-11114#** Japan Atomic Energy Research Inst., Tokyo.
**DESIGN STUDY FOR MEASUREMENT OF NEUTRAL HYDROGEN ATOM DENSITY BY LASER INDUCED FLUORESCENCE METHOD**
Toshihiko Yamauchi, Hiroaki Ogawa, Reiji Yamada, and Takeshi Fukuda Mar. 1987 25 p In JAPANESE; ENGLISH summary
(DE87-752964; JAERI-M-87-045) Avail: NTIS (US Sales Only) HC A03/MF A01

It is designed to measure the fluorescence light emitted from the transitions 1S - 2P of L sub alpha line (lambda = 1215 A) or 2P - 3S or 2P - 3D of H sub alpha line (lambda = 6563 A), excited by the laser induced fluorescence method. The signal-to-noise ratio (S/N) is evaluated at the measurement in the parameter (n-bar sub e = 10 sup 12 - 10 sup 14 cm sup -3, T sub e = 10 eV - 1 KeV) of tokamak plasma. The light paths in JFT-2M and JT-60 tokamaks are proposed. DOE

**N88-11115#** Toulouse Univ. (France).
**SILICON OXIDATION PHOTOASSISTED WITH A CONTINUOUS WAVE CO2 LASER BEAM AND CONTRIBUTION TO THE STUDY OF SILICA LAYERS OBTAINED Ph.D. Thesis - Institut National des Sciences Appliquees de Toulouse**
Annie Guedj 1987 173 p In FRENCH; ENGLISH summary
(LAAS-87-158; ETN-87-90642) Avail: NTIS HC A08/MF A01

A technology to achieve thin localized silica layers, required when reducing the size of microelectronic devices was developed. The oxide characteristics and reaction kinetics are studied using pyrometric and infrared spectroscopic techniques. The properties found show advantages compared with those of conventional thermal oxides. Transistors were implemented to demonstrate the applicability to MOS technologies. ESA

**N88-11116#** Toulouse Univ. (France). Lab. d'Automatique et d'Analyse des Systemes.
**QUANTUM WELL LASER DIODES: MODELING AND REALIZATION OF GaAs/GaAlAs Ph.D. Thesis - Paul Sabatier Univ.**
Beatrice Saint-Cricq 1987 126 p In FRENCH; ENGLISH summary
(LAAS-87-165; ETN-87-90643) Avail: NTIS HC A07/MF A01

The electrical and optical properties of semiconductor quantum well laser diodes are studied as well as manufacturing by molecular beam epitaxy. The theoretical analysis of the emission mechanism is based on an original model concerning the selection rules in the quantum well. A general methodology for the determination of the threshold current density is presented and optimization criteria for the quantum well laser diodes are discussed. Experimental results obtained with this structure show low threshold current and are in agreement with theoretical calculations. ESA

**N88-11117#** Loughborough Univ. of Technology (England). Dept. of Electrical and Electronical Engineering.
**A STUDY OF THE PERFORMANCE OF AIRBORNE LASER RADAR SYSTEMS AND TECHNIQUES M.S. Thesis**
J. Coyne Beng 1987 217 p
(ETN-87-90928) Avail: NTIS HC A10/MF A01

Helium-neon, neodymium (YAG), and CO2 laser radar systems are reviewed. Laser properties and hazards are discussed. Modulation techniques; optical detectors; beam steering; and signal processing are considered. System losses; atmospheric propagation; noise sources; and optical clutter are described. Laser radar range equations are analyzed. Applications including ranging, airborne surveillance and reconnaissance, wind velocity measurement, terrain following, and obstacle avoidance are treated. ESA

**N88-11118#** Lanchester Polytechnic, Coventry (England). Dept. of Mathematics.
**NUMERICAL SIMULATION OF LASER FILAMENTATION EXPERIMENTS**
D. J. Nicholas and S. G. Sajjadi May 1987 14 p
(ETN-87-90959) Avail: NTIS HC A03/MF A01

A numerical study of the filamentation of a laser beam in an ablating plasma was conducted to enable the physical parameters of the experiment to be defined and the layout of the laser beam and diagnostics to be decided. The role of plasma motion is commented on. The overall influence of the hydrodynamic motion on the filamentation instability is shown. The simulations are compared with Nicholas and Sajjadi (1986), when an idealized plasma density distribution was adopted. The general dependence of Z(Sf) on the initial beam intensity remains the same although always smaller than the value obtained without plasma motion. This leads at lower intensities to lower apparent thresholds for the instability. These scaling laws can readily be checked by experiment. ESA

**N88-11145*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**THE FOUR SPOT TIME-OF-FLIGHT LASER ANEMOMETER**
Mark P. Wernet *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 67-75 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20E

**N88-11176*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**CREEP-FATIGUE BEHAVIOR OF NiCoCrAlY COATED PWA 1480**
R. V. Miner, J. Gayda, and M. G. Hebsur *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 351-360 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20E

# 37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

**N88-11119#** Tecogen, Inc., Waltham, Mass.
**DEVELOPMENT OF A LIGHT DUTY GAS ENGINE FOR COGENERATION SERVICE Annual Report, Mar. 1985 - May 1986**
L. DiNanno and R. Raymond Aug. 1986 148 p
(Contract GRI-5084-243-1091)
(PB87-221297; TE4370-73-86; GRI-86/0226) Avail: NTIS HC A07/MF A01 CSCL 13I

The performance and maintenance requirements of a light-duty gas engine for cogeneration service was improved. The subject engine is a 454 cubic inch displacement automotive gasoline converted to operate on natural gas. This engine is currently used in cogeneration applications. It is the object to improve the performance, both in terms of output and efficiency, and to reduce its service requirements, thereby enhancing gas-fired cogeneration applications. Results indicate the potential for operating the engine at a rating of 75 kW with an efficiency improvement of 8 percent. These improvements were achieved through camshaft optimization and increased compression ratio. A 75 kW engine is currently being endurance tested. Work on extension of the service interval is focused on the oil change interval. The effects of sump size, oil type, type of filtration, fuel/air ratio, etc., are presented.
Author

**N88-11120#** Ricardo & Co., Engineers (1927) Ltd., Shoreham-by-Sea (England).
**APPLICATION OF ELECTRONIC FUEL INJECTION TO THE OPTIMUM ENGINE FOR METHANOL UTILIZATION Final Report**
May 1987 323 p
(Contract EPA-68-03-1968)
(PB87-201950; EPA/460/3-86/002) Avail: NTIS HC A14/MF A01 CSCL 21A

The report discusses research done in the application of electronic sequential fuel injection to an optimal engine for methanol utilization. The program was based on a production 1.5 liter Volkswagen gasoline engine, the combustion system of which was converted to HRCC (high ratio combustion chamber) with a compression ratio of 13:1. The engine had been developed to run on methanol fuel using a carburetor and mechanically controlled ignition and ERG system.
GRA

**N88-11121#** Department of Energy, Washington, D. C. Office of Transportation Systems.
**COATINGS FOR ADVANCED HEAT ENGINES WORKSHOP: BOOK OF ABSTRACTS**
1987 60 p Workshop held in Castine, Maine, 27-30 Jul. 1987
(DE87-012623; CONF-870762-Absts) Avail: NTIS HC A04/MF A01

This report is a collection of abstracts dealing with topics in internal combustion engine research. Subjects covered include: diesel and gas turbine engine research, adiabatic and low heat rejection diesel engines, thermal barrier coatings, tribology, ceramics, and combustion and emission research.
DOE

**N88-11122#** Oak Ridge National Lab., Tenn.
**PROCESS AND EQUIPMENT CAPABILITIES MATERIALS JOINING LABORATORY, 1987**
R. W. Reed, Jr. Aug. 1987 42 p
(Contract DE-AC05-84OR-21400)
(DE87-014534; ORNL/M-398) Avail: NTIS HC A03/MF A01

The Materials Joining Laboratory of the Metals and Ceramics Division has the capabilities and expertise to perform various types of joining emphasizing welding and brazing. Capabilities range from joining of heavy-section steels using a wide variety of welding technology to joining of small parts by brazing or welding. Expertise and facilities also exist for joining ceramic-to-ceramic or ceramic-to-metallic parts using brazing technology. In addition, a newly acquired plasma-spray system is available for coating research. With other laboratories and facilities within the Metals and Ceramics Division, a situation exists for extensive characterization of microstructure and properties of weldments. The Laboratory is fully equipped for the standard welding processes including gas tungsten arc, submerged arc, gas metal arc, and electroslag (ES). Specialized equipment includes pulsed and high-power continuous wave CO2 laser systems, high-power electron beam welding machines, internal bore tube-to-tubesheet welding system, narrow gap SA welding system, Gleeble thermomechanical simulator, and sessile drop apparatus for braze alloy wetting studies.
DOE

**N88-11123#** Pacific Northwest Labs., Richland, Wash.
**STIRLING ENGINE RESEARCH AT NATIONAL AND UNIVERSITY LABORATORIES IN JAPAN**
G. J. Hane and R. A. Hutchinson Sep. 1987 85 p
(Contract DE-AC06-76RL-01830)
(DE87-014622; PNL-6078) Avail: NTIS HC A05/MF A01

Pacific Northwest Laboratory (PNL) reviewed research projects that are related to the development of Stirling engines and that are under way at Japanese national laboratories and universities. The research and development focused on component rather than on whole engine development. PNL obtained the information from a literature review and interviews conducted at the laboratories and universities. The universities have less equipment available and operate with smaller staffs for research than do the laboratories. In particular, the Mechanical Engineering Laboratory and the Aerospace Laboratory conduct high-quality component and fundamental work. Despite having less equipment, some of the researchers at the universities conduct high-quality fundamental research. As is typical in Japan, several of the university professors are very active in consulting and advisory capacities to companies engaged in Stirling engine development, and also with government and association advisory and technical committees. Contacts with these professors and selective examination of their research are good ways to keep abreast of Japanese Stirling developments.
DOE

**N88-11124#** Technical Research Centre of Finland, Espoo.
**BOUNDARY LUBRICATION. EXPERIMENTS WITH BOUNDARY LUBRICATION AND PLAIN BEARINGS AT +60...-60 DEG C TEMPERATURES**
P. Koponen, M. Kytoe, E. Kuusisto, and O. Yloestalo Jan. 1987 71 p In FINNISH; In FINNISH
(DE87-752869; VTT-TIED-663) Avail: NTIS (US Sales Only) HC A04/MF A01

Boundary lubrication properties of different hydraulic oils and industrial transmission oils were compared. The lubricants consisted mainly of two mineral base oils (viscosity classes ISO VG 32 and ISO VG 150), with different wear inhibitors. Vegetable oils with and without additives, synthetic polyalphaolefins and synthetic esters were also used as lubricants. The wear inhibition and friction of about 20 test oils were measured both on standard test

equipment and on two modified plain bearing benches. One of the plain bearing benches is operated in cold conditions, in the temperature range from +20 to -60 deg C. The function of additives was also studied by monitoring the test specimens of the plain bearing experiments in an electron microscope. The significance of additives was clearly verified in the boundary lubrication experiments. The differences between the various additives were in most cases small at the lowest loads. In more severe conditions all additives no longer prevented wearing. There were also differences between the base oils. The rapidly reacting additives were more effective in short-term experiments in severe conditions. Different zinc ditiophosphates and sulphur phosphorus compounds are most general wear inhibitors and high-pressure additives.
DOE

**N88-11125#** Oak Ridge National Lab., Tenn.
**STIRLING ENGINES AND IRRIGATION PUMPING**
C. D. West Aug. 1987 37 p
(Contract DE-AC05-84OR-21400)
(DE88-000020; ORNL/TM-10475) Avail: NTIS HC A03/MF A01

This report was prepared in support of the Renewable Energy Applications and Training Project sponsored by the US Agency for International Development for which ORNL provides technical assistance. It briefly outlines the performance that might be achievable from various kinds of Stirling-engine-driven irrigation pumps. Some emphasis is placed on the very simple liquid-piston engines that have been the subject of research in recent years and are suitable for manufacture in less well-developed countries. In addition to the results quoted here (possible limits on $M^4$ and pumping head for different-size engines and various operating conditions), the method of calculation is described in sufficient detail for engineers to apply the techniques to other Stirling engine designs for comparison. The liquid-piston Fluidyne is a form of Stirling engine sharing many of the characteristics of conventional kinematic and free-piston Stirling machines. The use of liquid pistons, however, gives it some unique advantages as well as certain problems that are not encountered or are not important in engines with solid pistons. Because the output is naturally available in the form of an oscillating liquid flow or a fluctuating pressure, the Fluidyne is well suited to liquid pumping, but other applications have also been considered.
DOE

**N88-11126#** Lawrence Livermore National Lab., Calif.
**SOME SPECULATIONS ON THE MECHANISMS OF ABRASIVE GRINDING AND POLISHING**
N. J. Brown 11 May 1987 12 p Presented at the 4th International Precision Engineering Seminar, Cranfield, United Kingdom, 11 May 1987
(Contract W-7405-eng-48)
(DE87-014242; UCRL-96159; CONF-8705183-1) Avail: NTIS HC A03/MF A01

The mechanisms of grinding, a predominantly fracture mechanism in brittle material, and polishing, a predominantly plastic shearing mechanism, appear quite different. However, in a number of cases it can be shown that the difference between the two mechanisms can be triggered by differences in depth of cut and abrasive size. This paper will present results from recent polishing research that tend to support a physico-chemical interaction model involving aqueous diffusion, internal hydrolysis, and ion exchange mechanisms that may explain the plastic to brittle transition in silicate materials. The model would seem to have clear implications for both low scatter polishing and fine machining of silicate materials.
DOE

**N88-11127#** Massachusetts Inst. of Tech., Cambridge. Sloan Automotive Engine Lab.
**PISTON RING FRICTION AND VEHICLE FUEL ECONOMY Final Report, 1 Nov. 1983 - 31 Jan. 1987**
David P. Hoult Aug. 1987 31 p
(Contract DE-AC02-80ER-10743)
(DE87-014536; DOE/ER-10743/1) Avail: NTIS HC A03/MF A01

This project has involved three major tasks. They are: (1) the measurement of the transition of a piston ring, in a running engine, as it moves from the bottom to the top of the groove in the piston; (2) a theoretical analysis of the dynamics of a single piston ring; and (3) the setup and calibration of a laser fluorescence measurement technique for oil film thickness measurements. Highlights of the results are the discovery of a gas lubricated piston ring design, which holds promise for substantial reduction in piston ring friction, and successful operation at high temperatures and the application of the quantum mechanical principals necessary to correctly calibrate the laser-fluorescence technique in a running engine.
DOE

**N88-11128#** Rockwell International Corp., Golden, Colo. Rocky Flats Plant.
**LOW-PRESSURE EUTECTIC BONDING OF DEPLETED URANIUM TO COPPER**
J. L. Krankota, ed., C. M. Edstrom, ed., R. L. Thomas, ed., and L. M. Morales 22 May 1987 73 p
(Contract DE-AC04-76DP-03533)
(DE87-014625; RFP-3786) Avail: NTIS HC A04/MF A01

A bonding process using a nickel layer was developed and demonstrated for joining uranium plates to copper plates for heat-sink applications at the Savannah River Laboratory (SRL). The nickel was either electroplated onto the copper or inserted in the joints as a foil. Joints were made with bonding pressures from 15 to 100 psi in a vacuum of 10 -6 torr at 760°C, slightly above the eutectic temperature of 740°C. Bonding integrity was determined using ultrasonic, metallographic, and mechanical shear tests. The effect of uranium surface cleanliness on bond integrity was also investigated. An alternate joining technique using atmospheric pressure on a bagged and evacuated sandwich of copper and uranium plates was also investigated. These bagged sandwiches were heated using a flat induction coil. Other bonding agents, braze foils GAPASIL-9, CUSILTIN-10, and CUSIL, were also investigated. Good bonds were made using all bonding agents. However, the best bonds were made using nickel as the bonding agent.
DOE

**N88-11129#** Kauppa-ja Teollisuusministerio, Helsinki (Finland). Energiaosasto.
**USE OF NATURAL GAS DIESEL ENGINES IN MECHANICAL PULP PRODUCTION: A PRELIMINARY STUDY**
A. Niemi and K. Maaskola 1986 48 p In FINNISH
(DE87-753065; NEI-FI-19) Avail: NTIS (US Sales Only) HC A03/MF A01

Mechanical pulp production increases all the time which causes growth in electric power demand. The growth could be reduced by using dual fuel engines i.e., gas-diesel engines that use light fuel oil for ignition instead of electric engines. Mechanical powers and shaftspeeds of gas-diesel engines researched in this feasibility study are quite suitable - ratios of required gears are rather low. The profitability of the use of diesel engines for a single company depends very much on the prices of electricity and natural gas, and whether they have use for waste heat available from intercooling of combustion air, cylinder cooling water and lubrication oil cooling. The potential capacity of gas-diesel motor driven production of mechanical pulp will be 405,000 to 855,000 t/a by the year 2000, which would mean a decrease of 120 to 250 MW in the growth of electric power demand. The increase in mechanical power demand would correspondingly be 370 to 770 million FIM cheaper when using gas-diesel motors than if a coal power plant would be built and electric motors installed. The use of gas-diesel motors would decrease the rise in raw energy consumption by 0.2 to 0.9% of the total energy consumption in Finland in 1985.
DOE

**N88-11130#** National Aerospace Lab., Tokyo (Japan).
**THE WEAR PROCESS DURING THE RUNNING-IN OF STEEL IN LUBRICATED SLIDING**
Mineo Suzuki and Kenneth C. Ludema Feb. 1987 20 p
(NAL-TR-922T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

Steel cylinders were slid against flat steel disks, using a liquid lubricant, in order to study the progression of events associated with running-in. It was found that, when using mineral oil, the electrical contact resistance varied over a small range of high values indicating no metallic contact, whereas with engine oil a high resistance with an intermittent negligible contact resistance was found. A surface film forms from the additives in the engine oil which produces lower wear, slightly higher friction, a retarded running-in, and a rougher surface finish in the direction of the sliding than does the mineral oil. A film which is composed only of Fe3O4 is formed when mineral oil is used. In addition, the mineral oil lubricated surfaces develop a conforming waviness across the sliding tracks. The oxide must have enhanced this surface conformity since it was not seen in the surfaces lubricated with engine oil. The role of the oxide may be further seen in experiments in which wear debris that accumulated in the entrance regions of specimen contact was removed at frequent intervals. Little conforming waviness was seen in the latter case, suggesting that oxide which gathered in the entrance region abraded grooves in the steel surfaces. After the oxides were dislodged, the friction increased, and the contact resistance decreased for a time, indicating that the oxide acted like a solid lubricant. Author

**N88-11131#** Rolls-Royce Ltd., Derby (England). Technology Dept.
**BLADE EXCITATION CRITERIA DEVELOPED FOR AERO DERIVED ENGINES IN ARCTIC ALASKA**
H. J. Clough 31 May 1987 35 p Presented at the 32nd ASME International Gas Turbine Conference and Exhibition, Anaheim, Calif., 31 May - 4 Jun. 1987
(PNR-90368; ETN-87-90991) Copyright Avail: HC A03/MF A01

The method used for determining acceptable levels of high cycle fatigue stress on gas turbine blades from testing carried out in temperature climates is presented. The method encompasses photoelastic analysis; finite element stress and dynamic analysis; stress pattern analysis by thermal emission; laboratory vibration fatigue testing and strain gage calibration; and engine strain gage analysis and cyclic endurance testing. ESA

**N88-11132#** Rolls-Royce Ltd., Derby (England).
**MARINE GAS TURBINES - ENGINE HEALTH MONITORING, NEW APPROACHES**
J. Walker (Ministry of Defence, Bath, England ) and A. Summerfield 31 May 1987 19 p Presented at the 32nd ASME International Gas Turbine Conference and Exhibition, Anaheim, Calif., 31 May - 4 Jun. 1987
(PNR90369; ETN-87-90992) Copyright Avail: NTIS HC A03/MF A01

Advantages of adopting a policy of condition based maintenance for marine gas turbines rather than a rigid hours concept are outlined. Engine health monitoring developments and effects on overhaul facilities are explained. Visual inspection, low cycle fatigue counters, turbine life usage, power turbine entry temperature spread monitoring, aerothermal assessment, vibration monitoring, and debris are discussed. ESA

**N88-11133#** Rolls-Royce Ltd., Derby (England).
**TRANSMISSION EFFICIENCY IN ADVANCED AEROSPACE POWERPLANT**
J. A. Dominy 2 Feb. 1987 14 p Presented at the ASME/SAE/AIAA Joint Propulsion Conference, San Diego, Calif., 29 Jun. - 2 Jul. 1987
(PNR90391; TER662; TIA165189; ETN-87-90996) Copyright Avail: NTIS HC A03/MF A01

For aerospace powerplant requiring high power reduction gearboxes, an analytical method of estimating the efficiency of candidate transmissions was developed. The analysis was calibrated against an existing transmission and applied to gearboxes for single and contrarotating propfans and larger ultra-high-bypass ratio engines. In all cases the predicted efficiencies are broadly acceptable. The single most powerful influence is the gearbox configuration which is generally imposed by airframe requirements. ESA

**N88-11134#** Rolls-Royce Ltd., Derby (England).
**THE USE OF KEVLAR ON AERO-ENGINE FAN CONTAINMENT CASINGS**
I. F. Stewart 18 May 1987 9 p Presented at the Impact 87 Conference, Bremen, Federal Rep. of Germany, 18-22 May 1987
(PNR90410; ETN-87-91003) Copyright Avail: NTIS HC A02/MF A01

The use of Kevlar to reduce the weight of fan containment casings is described. Continuous layers of dry, woven Kevlar are wrapped around a light former (the casing). Upon release, the blade punctures the casing and its energy is absorbed by the whole circumference of Kevlar, unlike a traditional metal casing which has to be thick enough so that all the blade energy is absorbed in the local area of impact where the blade hits the casing. Tests indicate that casing weights 50% of ARMVO casings are achievable. A theoretical model for predicting Kevlar deflections was developed. Over a wide range of blade energies, weave types, wrapping tensions, and numbers of layers it gives good agreement with test results. The significant reduction in deflections predicted for increased wrapping tension agrees well with measured test results. ESA

**N88-11135*#** Timken Co., Canton, Ohio.
**IMPROVED OIL-OFF SURVIVABILITY OF TAPERED ROLLER BEARINGS Final Report, 1982 - 1987**
Gary E. Kreider and Peter W. Lee Oct. 1987 86 p
(Contract NAS3-23689; DA Proj. 1L1-61102-AH-45)
(NASA-CR-180804; NAS 1.26:180804; AVSCOM-TR-87-C-29)
Avail: NTIS HC A05/MF A01 CSCL 13I

The aim of this program is to improve the oil-off survivability of a tapered roller bearing when applied to a helicopter transmission, since the tapered bearing has shown a performance advantage in this application. However, the critical roller end-rib conjunction is vulnerable to damage in an oil-off condition. Three powdered metal materials were selected to use as the rib material for oil-off evaluation. These were: M2 steel to a 65% density, CBS 1000M 65% density, and CBS 1000M 75% density. The bearing styles tested were ribbed cone (inner race) and ribbed cup (outer race). Carburized solid CBS 600 was also used as a ribbed material for comparison of oil-off results. The tests were conducted at six speeds from 4000 rpm (0.26 million DN) through 37000 rpm (2.4 million DN).The ribbed cup style bearing achieved longer lives than the ribbed cone style. A standard bearing lasted only 10 minutes at 4000 rpm; however, the 30-min oil-off goal was achieved through 11000 rpm using the survivable ribbed cup bearing. The oil-off lives at 37000 rpm were less than 10 seconds. The grinding of the powder metal materials and surface preparation to achieve an open porosity is extremely critical to the oil-off performance of the powder metal component. Author

**N88-10839*#** Helium Leak Testing, Inc., Northridge, Calif.
**VACUUM PUMPS AND SYSTEMS: A REVIEW OF CURRENT PRACTICE**
Stuart Giles *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 95-11 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 13I

**N88-10853*#** Rockwell International Corp., Canoga Park, Calif.
**EVALUATION AND CERTIFICATION OF HEATER ASSEMBLIES DEVELOPED FOR THERMAL VACUUM ACCEPTANCE TESTING Abstract Only**
J. E. Allen *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 275 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 13I

**N88-10989#** Joint Publications Research Service, Arlington, Va.
**IMPROVING REPAIRABILITY OF GEARS**
S. A. Belyayev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 57-59 Transl. into ENGLISH from Mashinostroitel (Moscow, USSR), no. 5, May 1986 p 34 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

**N88-11181*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**COATING LIFE PREDICTION**
James A. Nesbitt and Michael A. Gedwill *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 397-404 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 13I

**N88-11182*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**THERMAL EXPANSION MISMATCH AND OXIDATION IN THERMAL BARRIER COATINGS**
G. C. Chang, W. Phucharoen (Cleveland State Univ., Ohio.), and R. A. Miller *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 405-425 (For primary document see N88-11140 02-39)
(Contract NCC3-27)
Avail: NTIS HC A19/MF A01 CSCL 13I

**N88-11183*#** Garrett Turbine Engine Co., Phoenix, Ariz.
**THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT**
T. E. Strangman, J. F. Neumann, and A. Tasooji *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 427-432 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 13I

**N88-11184*#** General Electric Co., Evendale, Ohio. Aircraft Engine Business Group.
**THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT**
R. V. Hillery, B. H. Pilsner, and E. C. Duderstadt *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 433-444 (For primary document see N88-11140 02-39)
(Contract NAS3-23943)
Avail: NTIS HC A19/MF A01 CSCL 13I

**N88-11185*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT**
J. T. DeMasi and K. D. Sheffler *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 445-455 (For primary document see N88-11140 02-39)
(Contract NAS3-23944)
Avail: NTIS HC A19/MF A01 CSCL 13I

# 38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

**N88-11136#** Sandia National Labs., Albuquerque, N. Mex.
**MULTIDIMENSIONAL ELEMENTAL ANALYSIS WITH THE SANDIA NUCLEAR MICROPROBE**
B. L. Doyle 1987 11 p Presented at the International Symposium on Applications of Ion Beams in Materials Science, Tokyo, Japan, 2 Sep. 1987
(Contract DE-AC04-76DP-00789)
(DE87-014158; SAND-87-1138C; CONF-8709120-1) Avail: NTIS HC A03

It is well known that many of the ion beam analysis techniques such as Rutherford backscattering spectrometry, elastic recoil detection, resonant and nonresonant nuclear reaction analysis can be used to nondestructively obtain concentration depth profiles of elements in solids. When these techniques are combined with the small beam spot capabilities of a scanned nuclear microprobe, sample composition can be determined in up to three dimensions. This paper will review the various procedures used to collect and analyze multidimensional data using the Sandia nuclear microprobe. In addition, examples of how these data are being used in the study of materials will be shown. DOE

**N88-11137#** Rolls-Royce Ltd., Derby (England).
**IMPLEMENTATION OF FINITE ELEMENT QUALITY ASSURANCE IN A COMMERCIAL INDUSTRIAL ORGANISATION**
J. M. Ball and J. Barlow 13 May 1987 22 p Presented at the NAFEMS International Conference, Brighton, United Kingdom, 13-15 May 1987
(PNR90393; ETN-87-90997) Copyright Avail: NTIS HC A03/MF A01

Experience in implementing finite element quality assurance standards and procedures in an aerospace mechanical technology organization is described. ESA

**N88-11138*#** Tracor, Inc., Austin, Tex.
**INCIPIENT FAULT DETECTION STUDY FOR ADVANCED SPACECRAFT SYSTEMS Final Report**
G. Martin Milner, Michael C. Black, J. Mike Hovenga, and Paul F. McClure 30 Nov. 1986 248 p
(Contract NAS9-17486)
(NASA-CR-172014; NAS 1.26:172014; DRL-T-1951; DRD-MA-183TH; T86-01-9561-U) Avail: NTIS HC A11/MF A01 CSCL 14D

A feasibility study to investigate the application of vibration monitoring to the rotating machinery of planned NASA advanced spacecraft components is described. Factors investigated include: (1) special problems associated with small, high RPM machines; (2) application across multiple component types; (3) microgravity; (4) multiple fault types; (5) eight different analysis techniques including signature analysis, high frequency demodulation, cepstrum, clustering, amplitude analysis, and pattern recognition are compared; and (6) small sample statistical analysis is used to compare performance by computation of probability of detection and false alarm for an ensemble of repeated baseline and faulted tests. Both detection and classification performance are quantified. Vibration monitoring is shown to be an effective means of detecting the most important problem types for small, high RPM fans and pumps typical of those planned for the advanced spacecraft. A preliminary monitoring system design and implementation plan is presented. Author

**N88-10987#** Joint Publications Research Service, Arlington, Va.
**ULTRASONIC MECHANIZED CHECKING OF WELD JOINTS OF NUCLEAR POWER PLANT EQUIPMENT**
V. M. Lantukh and M. Z. Tayts *In its* USSR Report: Engineering and Equipment 4 May 1987 p 21-24 Transl. into ENGLISH from Energetik (Moscow, USSR), no. 7, Jul. 1986 p 20-21 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

# 39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

**N88-11139#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
**RELIABILITY OF FINITE ELEMENT METHODS IN NORTH AMERICA**
Jerzy J. Kacprzynski Jul. 1987 25 p
(AGARD-R-748) Copyright Avail: NTIS HC A03/MF A01

The reliability of finite element analysis techniques in place of structural test are discussed in the context of airworthiness assessment. Using an example as illustration, it is shown that in order to obtain meaningful results, the analysis must be performed with extreme care by an experienced analyst. The reliance on the finite element analysis alone may result in serious misdiagnosis. The verification and the certification of programs and the certification of users are discussed. Some of the most important tests for validation of finite element programs are presented.
Author

**N88-11140*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**TURBINE ENGINE HOT SECTION TECHNOLOGY, 1985**
Oct. 1985 443 p Conference held in Cleveland, Ohio, 22-23 Oct. 1985
(NASA-CP-2405; E-2727; NAS 1.55:2405) Avail: NTIS HC A19/MF A01 CSCL 20K

The Turbine Engine Section Technology (HOST) Project Office of the Lewis Research Center sponsored a workshop to discuss current research pertinent to turbine engine hot section durability problems. Presentations were made concerning hot section environment and the behavior of combustion liners, turbine blades, and turbine vanes. For individual titles, see N88-11141 through N88-11185.

**N88-11141*#** Pratt and Whitney Aircraft, West Palm Beach, Fla. Engineering Div.
**FURTHER DEVELOPMENT OF THE DYNAMIC GAS TEMPERATURE MEASUREMENT SYSTEM** c35
D. L. Elmore, W. W. Robinson, and W. B. Watkins *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 37-43 (For primary document see N88-11140 02-39)
(Contract NAS3-24228)
Avail: NTIS HC A19/MF A01 CSCL 14B

Two experiments for verifying the frequency response of a previously-developed dynamic gas temperature measurement system were performed. In both experiments, fine-wire resistance temperature sensors were used as standards. The compensated dynamic temperature sensor data will be compared with the standards to verify the compensation method. The experiments are described in detail.
Author

**N88-11142*#** United Technologies Research Center, East Hartford, Conn.
**THE DEVELOPMENT OF A HIGH TEMPERATURE STATIC STRAIN GAGE SYSTEM** c35
Charles O. Hulse, Richard S. Bailey, and Howard P. Grant (Pratt and Whitney Aircraft, East Hartford, Conn.) *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 45-49 (For primary document see N88-11140 02-39)
(Contract NAS3-23722)
Avail: NTIS HC A19/MF A01 CSCL 14B

The objective of this program is to develop electrical resistance strain gages which will permit the measurement of static strains on nickel and cobalt superalloy parts inside gas turbine engines running on a test stand. The specific goal is to develop a complete system able to make strain measurements up to plus or minus 2000 mu strain with a total error of no more than plus or minus 10 percent over a 50 hour period at 1250 K. The initial part of this work consisted of a strain gage alloy development effort in which a variety of alloys were evaluated after being prepared by drop-casting or splat cooling.
Author

**N88-11143*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**DEVELOPMENT OF HEAT FLUX SENSORS FOR TURBINE AIRFOILS** c35
William H. Atkinson, Marcia A. Cyr, and Richard R. Strange *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 51-58 (For primary document see N88-11140 02-39)
(Contract NAS3-23529)
Avail: NTIS HC A19/MF A01 CSCL 14B

The objectives of this program are to develop heat flux sensors suitable for installation in hot section airfoils of advanced aircraft turbine engines and to experimentally verify the operation of these heat flux sensors in a cylinder in a cross flow experiment. Embedded thermocouple and Gardon gauge sensors were developed and fabricated into both blades and vanes. These were then calibrated using a quartz lamp bank heat source and finally subjected to thermal cycle and thermal soak testing. These sensors were also fabricated into cylindrical test pieces and tested in a burner exhaust to verify heat flux measurements produced by these sensors. The results of the cylinder in cross flow tests are given.
Author

**N88-11144*#** Northwestern Univ., Evanston, Ill.
**ELEVATED TEMPERATURE STRAIN GAGES** c35
J. O. Brittain, D. Geslin, and J. F. Lei *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 59-65 (For primary document see N88-11140 02-39)
(Grant NAG3-501)
Avail: NTIS HC A19/MF A01 CSCL 14B

Materials were evaluated that could be used in manufacturing electrical resistance strain gages for static strain measurements at temperatures at or above 1273 K. Strain gage materials must have a characteristic response to strain, temperature and time that is reproducible or that varies in a predictable manner within specified limits. Several metallic alloys were evaluated, as well as a series of transition metal carbides, nitrides and silicides.
Author

**N88-11145*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**THE FOUR SPOT TIME-OF-FLIGHT LASER ANEMOMETER** c36
Mark P. Wernet *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 67-75 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20E

The newly constructed, four-spot anemometer was shown to perform as predicted. The new anemometer's measurement region has the required characteristics: wide acceptance angle and high spatial selectivity to permit measurements in turbulent, hostile environments.
Author

**N88-11146*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**THE LEWIS STRAIN GAUGE LABORATORY: STATUS AND PLANS** c35
Howard F. Hobart and Herbert A. Will *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 77-79 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 14B

An in-house lab was established for developing, testing, and evaluating high-temperature strain gauges and to aid in in-house applications of high-temperature strain instrumentation. The lab is automated to provide computer control of oven temperatures, imposed strain, and data sampling.
Author

**N88-11147*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**CORRELATION OF VELOCITY AND VELOCITY-DENSITY TURBULENCE IN THE EXHAUST OF AN ATMOSPHERIC BURNER** c35
Gustave C. Fralick *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 81-85 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 14B

In the experiment described herein, temperature (density) and velocity are measured separately but simultaneously as functions of time so that it is possible to determine the relationships among velocity, density, and the product of density and velocity. An atmospheric burner rig was used to provide the flow for the experiment. Author

**N88-11148*#** Avco-Everett Research Lab., Mass.
**IMPROVED NUMERICAL METHODS FOR TURBULENT VISCOUS RECIRCULATING FLOWS Progress Report** c34
A. Turan *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 87-88 (For primary document see N88-11140 02-39)
(Contract NAS3-24351)
Avail: NTIS HC A19/MF A01 CSCL 20D

The hybrid-upwind finite difference schemes employed in generally available combustor codes possess excessive numerical diffusion errors which preclude accurate quantative calculations. The present study has as its primary objective the identification and assessment of an improved solution algorithm as well as discretization schemes applicable to analysis of turbulent viscous recirculating flows. The assessment is carried out primarily in two dimensional/axisymetric geometries with a view to identifying an appropriate technique to be incorporated in a three-dimensional code. Author

**N88-11149*#** General Motors Corp., Detroit, Mich. Gas Turbine Div.
**AEROTHERMAL MODELING PROGRAM, PHASE 2** c34
H. C. Mongia, S. V. Patankar, S. N. B. Murthy, J. P. Sullivan, and G. S. Samuelsen (California Univ., Irvine.) *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 89-108 (For primary document see N88-11140 02-39)
(Contract NAS3-24350)
Avail: NTIS HC A19/MF A01 CSCL 20D

The main objectives of the Aerothermal Modeling Program, Phase 2 are: to develop an improved numerical scheme for incorporation in a 3-D combustor flow model; to conduct a benchmark quality experiment to study the interaction of a primary jet with a confined swirling crossflow and to assess current and advanced turbulence and scalar transport models; and to conduct experimental evaluation of the air swirler interaction with fuel injectors, assessments of current two-phase models, and verification the improved spray evaporation/dispersion models. Author

**N88-11150*#** United Technologies Research Center, East Hartford, Conn.
**FUEL-INJECTOR/AIR-SWIRL CHARACTERIZATION** c34
J. B. McVey, J. B. Kennedy, and J. C. Bennett (Connecticut Univ., Storrs.) *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 109-117 (For primary document see N88-11140 02-39)
(Contract NAS3-24352)
Avail: NTIS HC A19/MF A01 CSCL 20D

The objectives of this program are to estabiish an experimental data base documenting the behavior of gas turbine engine fuel injector sprays as the spray interacts with the swirling gas flow existing in the combustor dome, and to conduct an assessment of the validity of current analytical techniques for predicting fuel spray behavior. Emphasis is placed on the acquisition of data using injector/swirler components which closely resemble components currently in use in advanced aircraft gas turbine engines, conducting tests under conditions that closely simulate or closely approximate those developed in actual combustors, and conducting a well-controlled experimental effort which will comprise using a combination of low-risk experiments and experiments requiring the use of state-of-the-art diagnostic instrumentation. Analysis of the data is to be conducted using an existing, TEACH-type code which employs a stochastic analysis of the motion of the dispersed phase in the turbulent continuum flow field. Author

**N88-11151*#** Minnesota Univ., Minneapolis.
**EFFICIENT NUMERICAL TECHNIQUES FOR COMPLEX FLUID FLOWS** c34
Suhas V. Patankar *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 119-120 (For primary document see N88-11140 02-39)
(Contract NAS3-596)
Avail: NTIS HC A19/MF A01 CSCL 20D

The aim of the present research program is the development of more efficient and reliable calculation schemes for the coupled momentum and continuity equations. The resulting schemes would significantly reduce the expense of computing complex flows such as those in combustion chambers, gas turbines, and heat exchangers. Author

**N88-11152*#** Garrett Turbine Engine Co., Phoenix, Ariz.
**COMBUSTOR-DIFFUSER INTERACTION PROGRAM** c07
R. Srinivasan and C. White *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 121-125 (For primary document see N88-11140 02-39)
(Contract F33615-84-C-2427)
Avail: NTIS HC A19/MF A01 CSCL 21E

A collection of empirical and analytical design methodology on combustor-diffuser systems was completed. A fully elliptic code was selected for analyzing the combustor-diffuser interaction. Analytical model predictions were obtained for all flow conditions at which Phase 2 tests will be conducted. These results will be compared with laser doppler velocimeter data. Furthermore, a generalized nonorthogonal grid system is being developed to accurately simulate complex wall shapes. Author

**N88-11153*#** Garrett Turbine Engine Co., Phoenix, Ariz.
**DILUTION JET MIXING PROGRAM, PHASE 3** c34
R. Srinivasan, G. Myers, and C. White *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 127-132 (For primary document see N88-11140 02-39)
(Contract NAS3-22110)
Avail: NTIS HC A19/MF A01 CSCL 20D

The objectives of the program were: (1) to extend the data base on mixing of a single-sided row of jets with a confined crossflow, (2) to collect a data base on mixing of multiple rows of jets with confined crossflow, (3) to develop empirical jet mixing correlations, and (4) to perform limited three-dimensional calculations for some of these test configurations. The tests were performed with uniform mainstream conditions for several orifice plate configurations. Schematics of the test section and the orifice configurations are given. Temperature and pressure measurements were made in the test section at 4 axial and 11 transverse stations, using a 60-element rake probe. The measured temperature distributions for these tests are reported. Author

**N88-11154*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ON THE MIXING OF A ROW OF JETS WITH A CONFINED CROSSFLOW** c34
J. D. Holdeman *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 133-138 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20D

Mean temperature profiles calculated with an interactive microcomputer code which evaluates dilution-zone design alternatives are presented to show the effects of flow and geometric variables on the mixing of a single row of jets injected through

sharp-edged orifices into a uniform flow of a different temperature in a constant area duct. In addition, this program is used to calculate profiles for opposed rows of jets with their centerlines in-line, by assuming that the confining effect of an opposite wall is equivalent to that of a plane of symmetry between opposed jets. Author

**N88-11155*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**HEAT TRANSFER IN A REAL ENGINE ENVIRONMENT** **c34**
Herbert J. Gladden *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 139-150 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20D

The hot section facility at the Lewis Research Center was used to demonstrate the capability of instruments to make required measurements of boundary conditions of the flow field and heat transfer processes in the hostile environment of the turbine. The results of thermal scaling tests show that low temperature and pressure rig tests give optimistic estimates of the thermal performance of a cooling design for high pressure and temperature application. The results of measuring heat transfer coefficients on turbine vane airfoils through dynamic data analysis show good comparison with measurements from steady state heat flux gauges. In addition, the data trends are predicted by the STAN5 boundary layer code. However, the magnitude of the experimental data was not predicted by the analysis, particularly in laminar and transitional regions near the leading edge. The infrared photography system was shown capable of providing detailed surface thermal gradients and secondary flow features on a turbine vane and endwell.
Author

**N88-11156*#** General Motors Corp., Indianapolis, Ind. Gas Turbine Div.
**FILM COOLING HEAT TRANSFER ON A TURBINE AIRFOIL** **c34**
Larry D. Hylton *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 151-159 (For primary document see N88-11140 02-39)
(Contract NAS3-24619)
Avail: NTIS HC A19/MF A01 CSCL 20D

The objectives of the current program are to develop an analytical approach, based on boundary layer theory, for predicting the effects of airfoil cooling on downstream heat transfer rates and to verify the resulting analytical method by comparison of predictions with hot cascade data obtained under this program.
Author

**N88-11157*#** Tennessee Univ. Space Inst., Tullahoma.
**FLOW FIELD MEASUREMENTS IN A 90 DEGREE TURNING DUCT** **c34**
Roger A. Crawford and Carroll E. Peters *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 161-164 (For primary document see N88-11140 02-39)
(Grant NAG3-617)
Avail: NTIS HC A19/MF A01 CSCL 20D

The objective of this investigation is the experimental evaluation of the influence of inlet turbulence intensity on secondary flow development in a turning duct. The existing 25.4 cm square turning duct (90) facility is being utilized to investigate of bulk turbulence levels on secondary flow development. The large scale duct flow facility allows detailed mean velocity and turbulence quantities to be measured at several streamwise planes in the curved duct. Non-intrusive laser velocimetry is being used to measure the mean and fluctuating components of velocity in all three orthogonal directions. To assure that the turbulence measurements are unbiased by particle lag and other effects, comparison hot wire data will be taken to validate the laser velocimetry system calibration.
Author

**N88-11158*#** United Technologies Research Center, East Hartford, Conn.
**MEASUREMENT OF AIRFOIL HEAT TRANSFER COEFFICIENTS ON A TURBINE STAGE** **c34**
Robert P. Dring, Michael F. Blair, and H. David Joslyn *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 165-173 (For primary document see N88-11140 02-39)
(Contract NAS3-23717)
Avail: NTIS HC A19/MF A01 CSCL 20D

A turbulence generating grid was designed and installed in the turbine inlet which produced the target nominal value of 10 percent free stream turbulence. Aerodynamic documentation of the rotor and stator midspan surface pressure distributions were obtained. Midspan heat transfer data were obtained on the rotor and stator for variations in inlet turbulence, rotor-stator axial spacing, and rotor incidence.
Author

**N88-11159*#** Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
**HEAT TRANSFER IN THE TIP REGION OF A ROTOR BLADE SIMULATOR** **c34**
D. E. Metzger, M. K. Chyu, and H. K. Moon *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 175-186 (For primary document see N88-11140 02-39)
(Grant NAG3-623)
Avail: NTIS HC A19/MF A01 CSCL 20D

The objective of this study of heat transfer in the tip region of a rotor blade simulator is to acquire, through experimental and computational approaches, improved understanding of the nature of the flow and convective heat transfer in the blade tip region. Such information should enable designers to make more accurate predictions of performance and durability, and should support the future development of improved blade tip cooling schemes.
Author

**N88-11160*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**COOLANT PASSAGE HEAT TRANSFER WITH ROTATION** **c34**
T. J. Hajek and A. W. Higgins *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 187-201 (For primary document see N88-11140 02-39)
(Contract NAS3-23691)
Avail: NTIS HC A19/MF A01 CSCL 20D

The objective is to develop a heat transfer and pressure drop data base, computational fluid dynamic techniques, and correlations for multi-pass rotating coolant passages with and without flow turbulators. The experimental effort is focused on the simulation of configurations and conditions expected in the blades of advanced aircraft high pressure turbines. With the use of this data base, the effects of Coriolis and buoyancy forces on the coolant side flow can be included in the design of turbine blades.
Author

**N88-11161*#** Stanford Univ., Calif. Thermosciences Div.
**HEAT TRANSFER WITH VERY HIGH FREE STREAM TURBULENCE** **c34**
Robert J. Moffat and Paul K. Maciejewski *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 203-215 (For primary document see N88-11140 02-39)
(Grant NAG3-522)
Avail: NTIS HC A19/MF A01 CSCL 20D

Stanton numbers as much as 350 percent above the accepted correlations for flat plate turbulent boundary layer heat transfer have been found in experiments on a low velocity air flow with very high turbulence (up to 50 percent). These effects are far larger that have been previously reported and the data do not correlate as well in boundary layer coordinates (Stanton number and Reynolds number) as they do in simpler coordinates: h vs. X. The very high relative turbulence levels were achieved by placing the test plate in different positions in the margin of a large diameter free jet. The large increases may be due to organized structures of large scale which are present in the marginal flowfield around a free jet.
Author

**N88-11162*#** Minnesota Univ., Minneapolis.
**PREDICTION OF TURBINE BLADE HEAT TRANSFER** **c34**
Suhas V. Patankar *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 217-219 (For primary document see N88-11140 02-39)
(Grant NAG3-579)
Avail: NTIS HC A19/MF A01 CSCL 20D

It is planned to incorporate a number of low Reynolds number turbulence models in a general two-dimensional boundary layer calculation procedure. This will be applied to different flow conditions over turbine blades and the predictions will be compared with experimental data. The prediction activity will lead to a recommendation about a satisfactory turbulence model for turbine blade heat transfer. Author

**N88-11163*#** Scientific Research Associates, Inc., Glastonbury, Conn.
**FLOW IN A MODEL TURBINE STATOR** **c34**
R. C. Buggein, S. J. Shamroth, and W. R. Briley *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 221-226 (For primary document see N88-11140 02-39)
(Contract NAS3-24358)
Avail: NTIS HC A19/MF A01 CSCL 20D

In view of the complex nature of the flowfield in the hot section of gas turbine engines, the need to predict heat transfer and flow losses, the possible appearance of separation and strong secondary flows, etc., the present effort is focusing upon a Navier-Stokes approach to the three dimensional turbine stator problem. The advantages of a full Navier-Stokes approach are clear since when combined with a suitable turbulence model these equations represent the flow and heat transfer physics. In particular, the Navier-Stokes equations accurately represent possible separated regions and regions of significant secondary flow. In addition, the Navier-Stokes approach allows representation of the entire flow field by a single set of equations, thus avoiding problems associated with representing different regions of the flow by different equations and then matching flow regions. Author

**N88-11164*#** General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
**3D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS**
L. T. Dame, P. C. Chen, M. S. Hartle, and H. T. Huang *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 227-237 (For primary document see N88-11140 02-39)
(Contract NAS3-23698)
Avail: NTIS HC A19/MF A01 CSCL 20K

The objective is to develop analytical tools capable of economically evaluating the cyclic time dependent plasticity which occurs in hot section engine components in areas of strain concentration resulting from the combination of both mechanical and thermal stresses. Three models were developed. A simple model performs time dependent inelastic analysis using the power law creep equation. The second model is the classical model of Professors Walter Haisler and David Allen of Texas A and M University. The third model is the unified model of Bodner, Partom, et al. All models were customized for linear variation of loads and temperatures with all material properties and constitutive models being temperature dependent. Author

**N88-11165*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**3-D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS** **c61**
E. S. Todd *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 239-243 (For primary document see N88-11140 02-39)
(Contract NAS3-23697)
Avail: NTIS HC A19/MF A01 CSCL 09B

The objective is to produce a series of new computer codes that permit more accurate and efficient three dimensional inelastic structural analysis of combustor liners, turbine blades, and turbine vanes. Each code embodies a progression of mathematical models for increasingly comprehensive representaion of the geometrical features, loading conditions, and forms of nonlinear material response that distinguish these three groups of hot section components. Author

**N88-11166*#** General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
**COMPONENT SPECIFIC MODELING** **c61**
R. L. McKnight and M. T. Tipton *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 245-257 (For primary document see N88-11140 02-39)
(Contract NAS3-23687)
Avail: NTIS HC A19/MF A01 CSCL 09B

The objective is to develop and verify a series of interdisciplinary modeling and analysis techniques that have been specialized to address three specific hot section components. These techniques will incorporate data as well as theoretical methods from many diverse areas including cycle and performance analysis, heat transfer analysis, linear and nonlinear stress analysis, and mission analysis. The new methods developed will be integrated to provide an accurate, efficient, and unified approach to analyzing combustor burner liners, hollow air-cooled turbine blades, and air-colled turbine vanes. For these components, the methods developed will predict temperature, deformation, stress, and strain histories throughout a complete flight mission. Author

**N88-11167*#** Akron Univ., Ohio.
**EXPERIMENTAL DETERMINATION OF FLOW POTENTIAL SURFACES SUPPORTING A MULTIAXIAL FORMULATION OF VISCOPLASTICITY** **c35**
J. R. Ellis and D. N. Robinson *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 259-269 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 14B

Details of the experimental procedure followed in a preliminary set of experiments conducted on the representative alloy type 316 stainless steel are given. Although primary interest is in the determination of initial and subsequent surfaces of constant inelastic strain rate (SCISR) at high homologous temperatures (e.g., approx. 0.5). The preliminary tests were conducted at lower temperatures (approx. 0.2) largely because of experimental convenience. Nevertheless, significant time-dependent response at the lower temperature allowed SCISR measurements to be carried out and an evaluation of the experimental technique made. Results of the preliminary tests are presented showing three of a family of initial SCISR's, including strain rate vectors for assessing the condition of normality. Conclusions are drawn concerning the feasibility of the experimental technique, the nature of the measured SCISR's and an assesssment of the normality condition. Finally, a discussion is given of future research. Author

**N88-11168*#** Cincinnati Univ., Ohio.
**CONSTITUTIVE MODELING FOR SINGLE CRYSTAL SUPERALLOYS** **c26**
Donald C. Stouffer, L. Thomas Dame, and N. Jayaraman *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 271-276 Prepared in cooperation with General Electric Co., Cincinnati, Ohio (For primary document see N88-11140 02-39)
(Grant NAG3-511)
Avail: NTIS HC A19/MF A01 CSCL 11F

A crystallographic approach to constitutive modeling of single crystal superalloys is discussed. The approach is based on identifying the active slip planes and slip directions. The shear stresses are computed on each of the slip planes from applied stress components. The slip rate is then computed on each slip system and the microscopic inelastic strain rates are the sum of the slip in the individual slip systems. The constitutive model was implemented in a finite element code using twenty noted isoparametric solid elements. Constants were determined for octahedral and cube slip systems. These constants were then used to predict tension-compression asymmetry and fatigue loops.

Other data was used to model the tensile and creep response.
Author

**N88-11169*#** Connecticut Univ., Storrs.
**CONSTITUTIVE MODELING OF SUPERALLOY SINGLE CRYSTALS WITH VERIFICATION TESTING** c26
Eric Jordan and Kevin P. Walker (Engineering Science Software, Inc., Smithfield, R.I.) *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 277-286 (For primary document see N88-11140 02-39)
(Grant NAG3-512)
Avail: NTIS HC A19/MF A01 CSCL 11F

The goal is the development of constitutive equations to describe the elevated temperature stress-strain behavior of single crystal turbine blade alloys. The program includes both the development of a suitable model and verification of the model through elevated temperature-torsion testing. A constitutive model is derived from postulated constitutive behavior on individual crystallographic slip systems. The behavior of the entire single crystal is then arrived at by summing up the slip on all the operative crystallographic slip systems. This type of formulation has a number of important advantages, including the prediction orientation dependence and the ability to directly represent the constitutive behavior in terms which metallurgists use in describing the micromechanisms. Here, the model is briefly described, followed by the experimental set-up and some experimental findings to date.
Author

**N88-11170*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**HIGH TEMPERATURE STRESS-STRAIN ANALYSIS**
Robert L. Thompson *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 287-301 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20K

The objectives of the high temperature structures program are threefold: to assist in the development of analytical tools needed to improve design analysis and procedures for the efficient and accurate prediction of the nonlinear structural response of hot-section components; to aid in the calibration, validation, and evaluation of the analytical tools by comparing predictions with experimental data; and to evaluate existing as well as advanced temperature and strain measurement instrumentation.
Author

**N88-11171*#** Southwest Research Inst., San Antonio, Tex.
**CONSTITUTIVE MODELING FOR ISOTROPIC MATERIALS**
Ulric S. Lindholm *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 303-306 (For primary document see N88-11140 02-39)
(Contract NAS3-23925)
Avail: NTIS HC A19/MF A01 CSCL 20K

The objective is to develop a unified constitutive model for finite element structural analysis of turbine engine hot-section components. This effort constitutes a different approach for non-linear finite-element computer codes which have heretofore been based on classical inelastic methods. The unified constitutive theory to be developed will avoid the simplifying assumptions of classical theory and should more accurately represent the behavior of superalloy materials under cyclic loading conditions and high temperature environments. During the first two years of the program, extensive experimental correlations were made with two representative unified models. The experiments were both uniaxial and biaxial at temperatures up to 1093 C (2000 F). In addition, the unified models were adopted to the MARC finite element code and used for stress analysis of notched bar and turbine blade geometries.
Author

**N88-11172*#** General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
**CONSTITUTIVE MODELING FOR ISOTROPIC MATERIALS**
V. G. Ramaswamy, R. H. VanStone, L. T. Dame, and J. H. Laflen *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 307-320 (For primary document see N88-11140 02-39)
(Contract NAS3-23927)
Avail: NTIS HC A19/MF A01 CSCL 20K

Constitutive theories were evaluated against a large uniaxial and multiaxial data base that was generated as part of this work. The experimental approach was to determine the constitutive behavior of Rene 80 under a multitude of conditions that are important in the design of gas turbine blades and vanes. The experimental and analytical goals of this program were successfully accomplished. A new multiaxial constitutive model which can represent the complex nonlinear high temperature behavior of Rene 80 was developed. The model was extensively verified on data at several temperatures.
Author

**N88-11173*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**CREEP FATIGUE LIFE PREDICTION FOR ENGINE HOT SECTION MATERIALS (ISOTROPIC): THIRD YEAR PROGRESS REVIEW**
Richard S. Nelson and John F. Schoendorf *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 321-327 (For primary document see N88-11140 02-39)
(Contract NAS3-23288)
Avail: NTIS HC A19/MF A01 CSCL 20K

This program is designed to investigate fundamental damage processes, identify modeling strategies, and develop practical models which can be used to guide the early design and development of new engines and to increase the durability of existing engines. A review is given of the base program, completed in 1984, which included the comparison and evaluation of several popular high-temperature life prediction approaches as applied to continuously cycled isothermal specimen tests. The option program, of which one year is completed, is designed to develop models which can account for complex cycles and loadings, such as thermomechanical cycling, cumulative damage, multiaxial stress/strain rates, and environmental effects.
Author

**N88-11174*#** General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
**ELEVATED TEMPERATURE CRACK GROWTH**
S. N. Malik, R. H. VanStone, K. S. Kim, and J. H. Laflen *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 329-340 (For primary document see N88-11140 02-39)
(Contract NAS3-23940)
Avail: NTIS HC A19/MF A01 CSCL 20K

The purpose is to determine the ability of currently available P-I integrals to correlate fatigue crack propagation under conditions that simulate the turbojet engine combustor liner environment. The utility of advanced fracture mechanics measurements will also be evaluated during the course of the program. To date, an appropriate specimen design, a crack displacement measurement method, and boundary condition simulation in the computational model of the specimen were achieved. Alloy 718 was selected as an analog material based on its ability to simulate high temperature behavior at lower temperatures. Tensile and cyclic tests were run at several strain rates so that an appropriate constitutive model could be developed. Suitable P-I integrals were programmed into a finite element post-processor for eventual comparison with experimental data.
Author

**N88-11175*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**LIFE PREDICTION AND CONSTITUTIVE MODELS FOR ENGINE HOT SECTION ANISOTROPIC MATERIALS PROGRAM**
G. A. Swanson *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 341-349 (For primary document see N88-11140 02-39)
(Contract NAS3-23939)
Avail: NTIS HC A19/MF A01 CSCL 20K

The purpose is to develop life prediction models for coated anisotropic materials used in gas temperature airfoils. Two single crystal alloys and two coatings are now being tested. These include PWA 1480; Alloy 185; overlay coating, PWA 286; and aluminide

coating, PWA 273. Constitutive models are also being developed for these materials to predict the plastic and creep strain histories of the materials in the lab tests and for actual design conditions. This nonlinear material behavior is particularly important for high temperature gas turbine applications and is basic to any life prediction system. Author

**N88-11176*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**CREEP-FATIGUE BEHAVIOR OF NiCoCrAlY COATED PWA 1480** c36
R. V. Miner, J. Gayda, and M. G. Hebsur *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 351-360 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20E

This study of high-temperature fatigue and creep-fatigue behavior is part of a program to identify the basic features of the effects of temperature, creep, fatigue, and environment on the behavior of a single crystal superalloy, a bulk coating alloy, and a coated alloy system. A system was selected which has had considerable production experience: the Ni-base superalloy, PWA 1480, and the NiCoCrAlY coating, PWA 276. Isothermal behavior was studied first. A series of fatigue and creep fatigue tests of the types commmonly designated as pp, cp, pc and cc were conducted. These teasts were conducted at various constant total strain ranges. The creep-fatigue cycles employed constant stress dwells at the maximum and/or minimum load. Test results are given. Author

**N88-11177*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**LEWIS' ENHANCED LABORATORY FOR RESEARCH INTO THE FATIGUE AND CONSTITUTIVE BEHAVIOR OF HIGH TEMPERATURE MATERIALS**
Michael A. McGaw *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 361-371 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 20K

Lewis Research Center's high temperature fatigue laboratory has undergone significant changes resulting in the addition of several new experimental capabilities. New materials testing systems have been installed enabling research to be conducted in multiaxial fatigue and deformation at high temperature, as well as cumulative creep-fatigue damage wherein the relative failure-life levels are widely separated. A key component of the new high-temperature fatigue and structures laboratory is a local, distributed computer system whose hardware and software architecture emphasizes a high degree of configurability, which in turn, enables the researcher to tailor a solution to the problem at hand. Author

**N88-11178*#** Yale Univ., New Haven, Conn. High Temperature Chemical Reaction Engineering Lab.
**TURBINE AIRFOIL DEPOSITION MODELS AND THEIR HOT CORROSION IMPLICATIONS** c26
D. E. Rosner and R. Nagarajan *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 373-381 (For primary document see N88-11140 02-39) (Grant NAG3-590)
Avail: NTIS HC A19/MF A01 CSCL 11F

This research project deals with the prediction of single- and multi-component salt(-solution) deposition, flow and oxide dissolution and their effects on the lifetime of turbine blades. Goals include rationalizing and helping to predict corrosion patterns on operational gas turbine (GT) rotor blades and stator vanes, and ultimately providing some of the tools required to design laboratory simulators and future corrosion resistant high-performance engines. Necessary background developments are reviewed. Results and tentative conclusions for single species (Na sub 2 SO sub 4 (1)) condensation, binary salt-solution (Na sub 2 SO sub 4-K sub 2 SO sub 4) condensation, and burner-rig testing of alloy materials are outlined. Author

**N88-11179*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EXPERIMENTAL VERIFICATION OF VAPOR DEPOSITION RATE THEORY IN HIGH VELOCITY BURNER RIGS** c26
Suleyman A. Goekoglu (Case Western Reserve Univ., Cleveland, Ohio.) and Gilbert J. Santoro *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 383-390 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 11F

The main objective has been the experimental verification of the corrosive vapor deposition theory in high-temperature, high-velocity environments. Towards this end a Mach 0.3 burner-rig appartus was built to measure deposition rates from salt-seeded (mostly Na salts) combustion gases on the internally cooled cylindrical collector. Deposition experiments are underway. Author

**N88-11180*#** General Electric Co., Cincinnati, Ohio.
**EFFECTS OF SURFACE CHEMISTRY ON HOT CORROSION LIFE** c26
R. E. Fryxell and G. E. Leese *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 391-396 (For primary document see N88-11140 02-39)
(Contract NAS3-23926)
Avail: NTIS HC A19/MF A01 CSCL 11F

This program has its primary objective: the development of hot corrosion life prediction methodology based on a combination of laboratory test data and evaluation of field service turbine components which show evidence of hot corrosion. The laboratory program comprises burner rig testing by TRW. A summary of results is given for two series of burner rig tests. The life prediction methodology parameters to be appraised in a final campaign of burner rig tests are outlined. Author

**N88-11181*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**COATING LIFE PREDICTION** c37
James A. Nesbitt and Michael A. Gedwill *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 397-404 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 13I

The investigation combines both experimental studies and numerical modeling to predict coating life in an oxidizing environment. The experimental work provides both input to and verification of two numerical models. The coatings being examined are an aluminide coating on Udimet 700 (U-700), a low-pressure plasma spray (LPPS) Ni-18Co-17Cr-24Al-0.2Y overlay coating also on U- 700, and bulk deposits of the LPPS NiCoCrAlY coating. Author

**N88-11182*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**THERMAL EXPANSION MISMATCH AND OXIDATION IN THERMAL BARRIER COATINGS** c37
G. C. Chang, W. Phucharoen (Cleveland State Univ., Ohio.), and R. A. Miller *In its* Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 405-425 (For primary document see N88-11140 02-39)
(Contract NCC3-27)
Avail: NTIS HC A19/MF A01 CSCL 13I

Thermal barrier coatings (TBC) for advanced gas turbine blades have been under intensive development during the last several years. This investigation is intended to achieve a clearer understanding of the mechanical behavior of plasma sprayed zirconia-yttria TBCs, involving a nickle-chromium-aluminum bond coat. The near term objectives are to study the stress states in a relatively simple model TBC subjected to steady state thermal loading. The resulting thermal expansion mismatch and oxidation have been primary targets for the study. The finite element approach and the effects of thermal mismatch and oxidation are described. A proposed mechanism for oxidation induced coating failure is also presented. Author

**N88-11183*#** Garrett Turbine Engine Co., Phoenix, Ariz.
**THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT** **c37**
T. E. Strangman, J. F. Neumann, and A. Tasooji *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 427-432 (For primary document see N88-11140 02-39)
Avail: NTIS HC A19/MF A01 CSCL 13I

This program focuses on predicting the lives of two types of strain-tolerant and oxidation-resistant thermal barrier coating (TBC) systems that are produced by commercial coating suppliers to the gas turbine industry. The plasma-sprayed TBC system is composed of a low pressure, plasma sprayed applied, oxidation resistant NiCrAlY bond coating. The other system is an air plasma sprayed yttria (8 percent) partially stabilized zirconia insulative layer.
Author

**N88-11184*#** General Electric Co., Evendale, Ohio. Aircraft Engine Business Group.
**THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT** **c37**
R. V. Hillery, B. H. Pilsner, and E. C. Duderstadt *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 433-444 (For primary document see N88-11140 02-39)
(Contract NAS3-23943)
Avail: NTIS HC A19/MF A01 CSCL 13I

The objectives are to determine the predominant modes of degradation of a plasma sprayed thermal barrier coating system, and then to develop and verify life prediction models accounting for these degradation modes. Two possible predominant failure mechanisms being evaluated are bond coat oxidation and bond coat creep.
Author

**N88-11185*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT** **c37**
J. T. DeMasi and K. D. Sheffler *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 445-455 (For primary document see N88-11140 02-39)
(Contract NAS3-23944)
Avail: NTIS HC A19/MF A01 CSCL 13I

The objective is to develop an integrated life prediction model accounting for all potential life-limiting thermal barrier coating (TBC) degradation and failure modes, including spallation resulting from cyclic thermal stress, oxidation degradation, hot corrosion, erosion and foreign object damage.
Author

**N88-11186*#** Rensselaer Polytechnic Inst., Troy, N.Y.
**COMPOSITE STRUCTURAL MATERIALS Annual Progress Report no. 50, 1 May 1986 - 30 Apr. 1987**
Robert G. Loewy and Stephen E. Wiberley Aug. 1987 93 p
(Grant NGL-33-018-003)
(NASA-CR-181416; NAS 1.26:181416) Avail: NTIS HC A05/MF A01 CSCL 20K

The development and application of composite materials to aerospace vehicle structures which began in the mid 1960's has now progressed to the point where what can be considered entire airframes are being designed and built using composites. Issues related to the fabrication of non-resin matrix composites and the micro, mezzo and macromechanics of thermoplastic and metal matrix composites are emphasized. Several research efforts are presented. They are entitled: (1) The effects of chemical vapor deposition and thermal treatments on the properties of pitch-based carbon fiber; (2) Inelastic deformation of metal matrix laminates; (3) Analysis of fatigue damage in fibrous MMC laminates; (4) Delamination fracture toughness in thermoplastic matrix composites; (5) Numerical investigation of the microhardness of composite fracture; and (6) General beam theory for composite structures.
Author

**N88-11187** Akron Univ., Ohio.
**BUCKLING OF VISCOELASTIC COLUMNS Ph.D. Thesis**
Shau Chew David Wang 1987 168 p
Avail: Univ. Microfilms Order No. DA8713629

The viscoelastic properties of elastomeric columns under buckling deformation were investigated. Three different types of loading, i.e., constant load, constant rate, and dynamic deformation were applied to columns with different slenderness ratios and carbon black contents. Under constant loading, the time to buckle is dependent on the amount of axial and lateral load as well as the inherent stress relaxation characteristics of the columns. The initial lateral deflection could strongly affect the critical buckling time. The existence of a master curve can easily explain the interrelationship among the critical buckling time, the lateral load, the Euler load, and the column slenderness ratio. Under constant rate deformation, the load-deflection curve and the energy loss are controlled by the carbon black content, the column slenderness ratio, and the deformation rate. The buckling behavior can also be predicted through the application of the Boltzmann superposition principle associated with the stress relaxation modulus.
Dissert. Abstr.

**N88-11188** Notre Dame Univ., Ind.
**APPLICATIONS OF DISLOCATION THEORY TO CRACK GROWTH PROBLEMS Ph.D. Thesis**
Steven Glenn Russell 1987 161 p
Avail: Univ. Microfilms Order No. DA8712956

The applications of the dislocation theory to crack growth problems is presented. The growth of cracklike grain boundary voids undergoing a diffusive creep process is studied. The voids are located on grain boundaries that are symmetric with respect to a grain boundary containing a semi-infinite macrocrack which is loaded by remote tension. A stress analysis of the grain boundary voids is performed and an integro-differential equation describing the transient growth of the voids by grain boundary diffusion is derived and solved numerically. All plastic deformations of the materials are neglected. The results obtained reveal the nature of the time-dependent stress distribution near the voids and establish trends for the variation of the void extension rates with respect to time. The second study presents a model for the fracture process zone near the tip of a steadily propagating plane strain tensile crack. The macroscopic plastic deformation near the advancing crack tip is modeled by a slip element approach in which dislocations are continuously distributed over a planar region. The fracture process zone is modeled by a continuous distribution of dislocations collinear with the advancing crack tip. The results reveal the influence of the fracture process zone on the slip line pattern within the crack tip plastic zone and the elasto-plastic boundary.
Dissert. Abstr.

**N88-11189** Michigan State Univ., East Lansing.
**A NUMERICAL METHOD FOR THE TREATMENT OF KINKED CRACKS IN FINITE BODIES Ph.D. Thesis**
Ukhwan Sur 1987 82 p
Avail: Univ. Microfilms Order No. DA8714370

A displacement discontinuity method is developed for modelling cracks in linear-elastic two-dimensional infinite domains. This method is then coupled to the standard boundary-element method for the treatment of cracks in finite two-dimensional regions. The hybrid approach has been implemented on the computer and representative results are presented. Problems studied include a variety of crack shapes, including cracks with kinks. The hybrid method is shown to be an effective technique for the study of cracks of arbitrary shape in finite bodies. The ability of the method to handle cracks with kinks is a distinct advantage over other known approaches. Furthermore, the application of this method to crack propagation problems possesses none of the computational problems associated with other approaches.
Dissert. Abstr.

**N88-11190#** Sandia National Labs., Albuquerque, N. Mex.
**FROZEN-FIELD, RIGID-BEAM, UNIFORM-CONDUCTIVITY-CHANNEL TRACKING FORCE CALCULATION**
K. J. OBrien Jun. 1987 36 p

(Contract DE-AC04-76DP-00789)
(DE87-012510; SAND-87-0455) Avail: NTIS HC A03/MF A01

The linearized restoring force, experienced by a displaced rigid-beam entirely contained within a uniform conductivity channel, has been calculated using the frozen-field approximation. It has been determined that for a speed-of-light beam the net restoring force is purely electric, in the sense that part of the electric force exactly cancels the entire magnetic force, leaving only a residual electric force. The force rises with zeta to an asymptotic value which scales as I/sub b/ /a c dynes (up to geometrical and conductivity factors) for a beam displaced by d whose current rises to a constant value I/sub b/. GRA

**N88-11191#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.
**AN ACOUSTIC EMISSION DIGITAL DATA ACQUISITION WORKSTATION**
John A. Johnson, Basil A. Barna, and Randy T. Allemeier 1987 8 p Presented at the 5th Symposium on Energy Engineering Sciences, Argonne, Ill., 17 Jun. 1987
(Contract DE-AC07-76ID-01570)
(DE87-012425; EGG-M-16687; CONF-870679-3) Avail: NTIS HC A02/MF A01

A digital acoustic emission (AE) data acquisition system is used to record the acoustic emissions generated by individual crack initiation sites during fracture. This research analyzes the dynamics of crack growth and discriminates among fracture mechanisms through pattern analysis of the received signals. Preliminary experiments were performed using a laser as an AE source for calibration, and data were collected from a tensile test of an aluminum surface-cracked specimen. During the laser calibration experiments the AE from a focused Nd-YAG laser spot, which was translated 2.0 mm across a sample in 0.1 mm steps, was recorded and used to locate the origin of the AE. The results showed the basic capability of the system to discriminate between initiation sites less than 100 microns apart. The aluminum fracture experiment showed the capability of an enhanced system to record real events with a response time of less than 12 ms between events. The dynamics of the initiation site evolution show the progression of the crack growth across the pre-crack tip. Research is now being pursued to both validate these preliminary results and apply the information to the dynamics of the fracture event. DOE

**N88-11192#** Oak Ridge Gaseous Diffusion Plant, Tenn. Materials Engineering Dept.
**DAMPING CHARACTERISTICS OF A COMPOSITE-REINFORCED STAINLESS-STEEL TUBE**
J. B. Andriulli and H. J. Grimsby Jun. 1987 18 p
(Contract DE-AC05-84OT-21400)
(DE87-012455; K/ETAC-23) Avail: NTIS HC A03/MF A01

The investigation of damping characteristics of composite-steel laminates was initiated for the Naval Underwater Systems Center in March 1987. Phase I of the Composite Damping Task consists of fabricating a hoop-wound, fiber reinforced stainless-steel tube and comparing the damping characteristics to that of a bare stainless-steel tube. This report summarizes the activities initiated under Phase I of this project performed at the Enrichment Technology Applications Center, Martin Marietta Energy Systems, Inc. DOE

**N88-11193#** International Centre for Theoretical Physics, Trieste (Italy).
**ANELASTIC BEHAVIOUR OF MATERIALS UNDER MULTIAXIAL STRAINS. PART 3: ORDER-DISORDER TRANSITION, SHOEK EFFECT AND POISSON'S RATIO IN AISI-1080 STEEL**
R. E. Bolmaro and F. Povolo Nov. 1986 23 p
(DE87-703087; IC-86/374) Avail: NTIS (US Sales Only) HC A03/MF A01

Data on Young's modulus and Poisson's ratio obtained in AISI-1080 steel, in the temperature region between about 300 and 600 K, are presented. The measurements have been performed in longitudinal excitation and several harmonics were used, to obtain Poisson's ratio from the measured resonant frequencies. The maximum observed in the temperature dependence of Young's modulus, for the fundamental resonant frequency, is attributed to a stress-induced disordering of carbon atoms in the octahedral interstices of the martensitic matrix. The increases of Young's modulus with temperature are described in terms of expressions deduced in the paper, which are based on Landau theory of second order phase transitions. The critical temperature is related to the M sub s and M sub f temperatures which characterize the martensitic phase transition. Finally, the temperature dependence of Poisson's ratio is described in terms of a theory of anelastic behavior under multiaxial strains, based on the standard anelastic solid model. DOE

**N88-11194#** Stanford Univ., Calif.
**ENERGY CHANGES IN TRANSFORMING SOLIDS Final Report, 1 Apr. 1982 - 30 Nov. 1986**
G. Herrmann and D. M. Barnett 1987 16 p
(Contract DE-AS03-82ER-12040)
(DE87-011257; DOE/ER-12040/T1) Avail: NTIS HC A03/MF A01

This research covers conservation (balance) laws in defect mechanics, energy release rates in elastic body, conservation laws in dislocation continuum, gauge field theory of a continuum with dislocations and disclinations, hoop stresses around circular holes in elastic sheets, fracture of nonhomogeneous materials, thermodynamics of continuous damage in solids, layered composites, and misfitting or transformed inclusions and dislocations in impure solids. DOE

**N88-11195#** Sandia National Labs., Albuquerque, N. Mex. Experimental Mechanics Dept.
**ASSESSMENT OF STRUCTURAL INTEGRITY FROM FORCED VIBRATION TESTING**
J. D. Rogers 1987 5 p Presented at the SEM Fall Meeting, Savannah, Ga., 25 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-014642; SAND-87-0174C; CONF-8710135-1) Avail: NTIS HC A02/MF A01

A method for using forced vibration testing as a diagnostic of structural integrity is presented. An experimental study of the forced vibration response of a simple beam structure with masses attached near the ends by bolted joints is discussed. The beam was soft-supported to simulate free-free boundary conditions and was excited at its midpoint by an electrodynamic shaker. The dynamic response of the beam was characterized by the measured autcspectra and frequency response functions. The effect of joint tightness on the dynamic response of the system was identified through the change in the resonant frequency and the change in the frequency response function at resonance. DOE

**N88-11196#** Japan Atomic Energy Research Inst., Tokyo.
**INVESTIGATION ON DUCTILE FRACTURE BEHAVIOR OF 3-INCH DIAMETER TYPE 304 STAINLESS STEEL PIPE WITH A CIRCUMFERENTIAL THROUGH-WALL CRACK**
Yuji Yasuda, Katsuyuki Shibata, Kunio Onizawa, Takaichi Kawamura, Toshihiro Ohba, and Shohachiro Miyazono May 1987 124 p In JAPANESE; ENGLISH summary
(DE87-753016; JAERI-M-87-068) Avail: NTIS (US Sales Only) HC A06/MF A01

At Japan Atomic Energy Research Institute (JAERI), a pipe fracture test program has been conducted as a part of the Leak-Before-Break (LBB) verification research in LWR pressure boundary pipings. In this program, fracture behavior and fracture criteria of the circumferentially cracked pipe have been investigated, using austenitic stainless steel pipes and carbon steel pipes. This report presents a four-point bending test results of 3-inch diameter Type 304 austenitic stainless steel pipes with circumferential through-wall crack at room temperature. Pipe fracture data were obtained from the test in regard to load-loadline displacement, crack extension, crack opening area, and so on. Discussions are performed on the effect of pipe ovalization ratio at maximum load, the application of the net-section collapse criterion, and the effect

of initial crack angle, wall-thickness etc., on J-R curve. Furthermore, the crack opening area was estimated by assuming a simple crack model. DOE

**N88-11197#** Mitsubishi Heavy-Industries Ltd., Tokyo (Japan).
**SOME NEW FATIGUE TESTS IN HIGH TEMPERATURE WATER AND LIQUID SODIUM ENVIRONMENT**
Takahiro Hattori, Takayoshi Yamauchi, Hiroshi Kanasaki, Yoshiyuki Kondo, and Tadayoshi Endo Jan. 1987 9 p
(DE87-753019; MTB-175) Avail: NTIS (US Sales Only) HC A02/MF A01

To evaluate the fatigue strength of structural materials for PWR or FBR plants, fatigue test data must be obtained in an environment of simulated primary and secondary water for PWR or of high temperature liquid sodium for FBR. Generally, such tests make it necessary to prepare expensive facilities, so when large amount of fatigue data are required, it is necessary to rationalize and simplify the fatigue tests while maintaining high accuracy. At the Takasago Research Development Center, efforts to rationalize facilities and maintain accuracy in fatigue tests have been made by developing new test methods and improving conventional techniques. This paper introduces a new method of low cycle fatigue test in high temperature water, techniques for automatic measurement of crack initiation and propagation in high temperature water environment and a multiple type fatigue testing machine for high temperature liquid sodium. DOE

**N88-11198#** Aeronautical Research Labs., Melbourne (Australia).
**THE INFLUENCE OF LOAD CYCLE RECONSTITUTION ON FATIGUE BEHAVIOUR**
J. M. Finney and F. G. Harris Aug. 1986 37 p
(ARL-STRUC-R-424; AR-004-498) Avail: NTIS HC A03/MF A01

Fatigue experiments have been conducted to assess the influence of the method of reconstituting a load sequence from a range-pair counted load spectrum for a fighter aircraft. In addition to the original flight-by-flight sequence, several quite-structured reconstituted sequences and random reconstituted sequences were used, all sequences having identical range-pair counts. There was little or no difference in crack propagation lives or total lives of two specimen geometries for the several structured sequences which were designed to give the extremes in crack growth life. There was, also, no significant difference in crack propagation lives for specimens tested under the flight-by-flight and random sequences. Crack growth under the more structured sequences was significantly slower than under the more fluctuating sequences (random and flight-by-flight), though the maximum difference of 1.59:1 is small relative to other uncertainties in fatigue life assessment. These results provide a basis for implementing the Aircraft Fatigue Data Analysis System which utilizes strain range-pair counting. Author

**N88-11199#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de la Resistance des Structures.
**PREDICTION OF FATIGUE CRACKING AND RUPTURE OF LARGE STRUCTURES Final Report [PREVISION DE LA FISSURATION PAR FATIGUE ET LA RUPTURE DES STRUCTURES MASSIVES]**
R. Labourdette, G. Baudin, M. Robert, and J. Devoucoux Feb. 1987 47 p In FRENCH
(Contract DRET-85/34-001)
(ONERA-RT-31/7169-RY-055-R; ETN-87-90906) Avail: NTIS HC A03/MF A01

Prediction of crack propagation under mini-TWIST type loading and comparison of theory and experiment at the same values of stress intensity factors and number of cycles are described. The quality of the model predictions is satisfactory, being of the same order found in the two dimensional model. Results obtained with cracked specimens show the existence of an instability condition related to the maximum stress intensity factor found in a given front. ESA

**N88-11200#** Oxford Univ. (England). Dept. of Engineering Science.
**MATERIAL BEHAVIOUR AT HIGH RATES OF STRAIN**
J. Harding 1987 24 p Presented at IMPACT 87, Bremen, Federal Rep. of Germany, 18-22 May 1987 Submitted for publication
(OUEL-1684/87; ETN-87-90973) Avail: NTIS HC A03/MF A01

Stress-dependent terms in the mechanical equation of state; strain-dependent terms in the mechanical equation of state; strain-rate history effects and constitutive relations for strain-rate jump tests are discussed. Use of an internal structure sensitive parameter is described. Experimental data at strain rates up to 10,000/sec were obtained. ESA

**N88-11201#** Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (West Germany).
**REVIEW OF INVESTIGATIONS OF AERONAUTICAL FATIGUE IN THE FEDERAL REPUBLIC OF GERMANY Review Period May 1985 - May 1987**
O. Buxbaum and H. Huth May 1987 72 p Presented at the 20th International Committee on Aeronautical Fatigue Conference, Ottawa, Ontario, 1987
(LBF-S-178; ISSN-0721-5320; ETN-87-91053) Avail: NTIS HC A04/MF A01

Measurement and analysis of operational loads; fatigue behavior of notched and unnotched materials; low cycle fatique; crack propagation and fracture mechanics; environmental influences on composites; damage mechanisms; joints; fatigue life predictions; and component and full scale tests are discussed. ESA

**N88-11202*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**AGARD STANDARD AEROELASTIC CONFIGURATIONS FOR DYNAMIC RESPONSE. CANDIDATE CONFIGURATION I.-WING 445.6**
E. Carson Yates, Jr. Aug. 1987 78 p
(NASA-TM-100492; NAS 1.15:100492) Avail: NTIS HC A05/MF A01 CSCL 20K

To promote the evaluation of existing and emerging unsteady aerodynamic codes and methods for applying them to aeroelastic problems, especially for the transonic range, a limited number of aerodynamic configurations and experimental dynamic response data sets are to be designated by the AGARD Structures and Materials Panel as standards for comparison. This set is a sequel to that established several years ago for comparisons of calculated and measured aerodynamic pressures and forces. This report presents the information needed to perform flutter calculations for the first candidate standard configuration for dynamic response along with the related experimental flutter data. Author

**N88-10990#** Joint Publications Research Service, Arlington, Va.
**PROCEEDINGS OF CONFERENCE ON VIBRODIAGNOSTICS DISCUSSED**
*In its* USSR Report: Engineering and Equipment 4 May 1987 p 67-69 Transl. into ENGLISH from Mashinovedeniye (Moscow, USSR), no. 4, Jul. - Aug. 1986 p 103-104 Presented at the 1st All-Union Conference on Problems in Vibroacoustic Diagnostica for Machines and Equipment, Ivanova (USSR), 9-11 Sep. 1985 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

**N88-10991#** Joint Publications Research Service, Arlington, Va.
**VIBRATION-ABSORBING CHARACTERISTICS OF METAL-POLYMER SHELLS Abstract Only**
V. M. Chernyshev *In its* USSR Report: Engineering and Equipment 4 May 1987 p 79 Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy: Machinostroyeniye (Moscow, USSR), no. 8, Aug. 1986 p 38-43 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

**N88-11000#** Joint Publications Research Service, Arlington, Va.
**NONSTEADY-STATE VIBRATIONS IN ACOUSTIC MEDIUM OF ELASTIC ELLIPTICAL SHELL SUBJECTED TO INSTANTANEOUSLY APPLIED UNIFORM PRESSURE Abstract Only**
V. V. Karpenko, A. S. Pankratov, and V. I. Saygina *In its* USSR Report: Engineering and Equipment 4 May 1987 p 113 Transl. into ENGLISH from Mekhanika Tverdogo Tela (Moscow, USSR), no. 2, Feb. 1986 p 173-179 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

# 42 GEOSCIENCES (GENERAL)

No abstracts in this category.

# 43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

**N88-11203*#** National Aeronautics and Space Administration, Washington, D.C.
**HOW WE GET PICTURES FROM SPACE, REVISED EDITION**
Robert Haynes [1987] 12 p Original contains color illustrations
(NF-151/7-87-Rev; NAS 1.20:151/7-87-Rev) Avail: NTIS HC A03/MF A01; also available SOD HC $1.00 as 033-000-01005-2 CSCL 05B

The past 25 years of space travel and exploration have generated an unprecedented quantity of data from planetary systems. Data gathered at close range, and from above the distorting effects of Earth's atmosphere, produce images far more detailed than pictures taken by even the largest Earth-bound telescopes. The techniques used to acquire and process these images are discussed briefly. B.G.

**N88-11204*#** National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, Va. Dept. of Geography.
**CORRELATION BETWEEN AIRCRAFT MSS AND LIDAR REMOTELY SENSED DATA ON A FORESTED WETLAND IN SOUTH CAROLINA**
John R. Jensen, Michael E. Hodgson, Halkard E. Mackey, Jr. (Du Pont de Nemours, E. I. and Co., Aiken, S.C ), and William Krabill 1987 42 p Presented at the Fall Convention of the American Society of Photogrammetry and Remote Sensing, Reno, Nev., 4-9 Oct. 1987 Submitted for publication
(Contract DE-AC09-76SR-00001)
(NASA-TM-89643; NAS 1.15:89643; DE87-011229; DP-MS-87-15; CONF-871098-1) Avail: NTIS HC A03/MF A01 CSCL 02F

Wetlands in a portion of the Savannah River swamp forest, the Steel Creek Delta, were mapped using April 26, 1985 high-resolution aircraft multispectral scanner (MSS) data. Due to the complex spectral characteristics of the wetland vegetation, it was necessary to implement several techniques in the classification of the MSS imagery of the Steel Creek Delta. In particular, when performing unsupervised classification, an iterative cluster busting technique was used which simplified the cluster labeling process. In addition to the MSS data, light detecting and ranging (LIDAR) data were acquired by National Aeronautics and Space Administration (NASA) personnel along two flightlines over the Steel Creek Delta. These data were registered with the wetland classification map and correlated. Statistical analyses demonstrated that the laser derived canopy height information was significantly correlated with the Steel Creek Delta wetland classes encountered along the profiling transect of the LIDAR data. DOE

**N88-11205*#** Purdue Univ., West Lafayette, Ind. Lab. for Applications of Remote Sensing.
**ESTIMATING SCATTERED AND ABSORBED RADIATION IN PLANT CANOPIES BY REMOTE SENSING Final Report**
G. S. T. Daughtry and K. J. Ranson 16 Nov. 1987 22 p
(Grant NAG5-771)
(NASA-CR-181390; NAS 1.26:181390; LARS-071587) Avail: NTIS HC A03/MF A01 CSCL 02F

Several research avenues are summarized. The relationships of canopy characteristics to multispectral reflectance factors of vegetation are reviewed. Several alternative approaches for incorporating spectrally derived information into plant models are discussed, using corn as the main example. A method is described and evaluated whereby a leaf area index is estimated from measurements of radiation transmitted through plant canopies, using soybeans as an example. Albedo of a big bluestem grass canopy is estimated from 60 directional reflectance factor measurements. Effects of estimating albedo with substantially smaller subsets of data are evaluated. Author

**N88-11206#** Institute of Oceanographic Sciences, Wormley (England).
**OBSERVATIONS OF WIND WAVES ON A RESERVOIR**
K. G. Birch and J. A. Ewing 1986 36 p
(IOS-234; ETN-87-90673) Avail: NTIS HC A03/MF A01

Wind waves on a reservoir, where the longest fetch is 1km, were measured using an array of wave staffs and an electromagnetic current meter. The results show that the scaling laws of Kitaigorodskii (1962) are obeyed on this scale. The variation of nondimensional wave energy and nondimensional peak frequency are functions of nondimensional fetch in agreement with expressions derived during the Joint North Sea Wave Project (JONSWAP). The one-dimensional frequency spectra are close to the JONSWAP form with a high frequency tail varying as frequency to the power minus 5 in accordance with Phillips' (1958) hypothesis. There appears to be a limited region above the spectral peak where a wind speed dependent and a frequency to the power minus 4 spectral behavior is observed. Wave directional spectra obtained from an array of wave staffs and an electromagnetic current meter indicate a narrower angular distribution than measured under fetch limited conditions in the ocean. ESA

**N88-11207#** Institute of Oceanographic Sciences, Birkenhead (England).
**VERTICAL PROFILES OF WIND-INDUCED CURRENT**
Norman S. Heaps and J. E. Jones Mar. 1987 52 p
(IOS-238; ETN-87-90674) Avail: NTIS HC A04/MF A01

Ekman-type current profiles are constructed for 5 positions in the North Sea and for a range of wind speeds between 5 and 40 m/sec. Their application to determine the vertical distribution of extreme surge current is described. The extent to which logarithmic surface and bottom boundary layers influence the calculated profiles is investigated. ESA

**N88-11208#** Mullard Space Science Lab., Dorking (England).
**AN EXPLORATORY STUDY OF INLAND WATER AND LAND ALTIMETRY USING SEASAT DATA Final Report**
C. G. Rapley, M. A. J. Guzkowska, W. Cudlip, and I. M. Mason Paris, France ESA Feb. 1987 377 p
(Contract ESTEC-6483/85-NL-BI)
(ESA-CR(P)-2433; ETN-87-90889) Avail: NTIS HC A17/MF A01

Ten million Seasat radar altimeter echo waveforms from inland water and land were analyzed. The results include a comparison of altimeter tracking continuity with the spatial variability of surface elevation, and the association of types of return echo with geographic classes of surface. Case studies of lakes, deserts, wetlands, and rivers are described. The effects of gravity on the surfaces of large lakes and their correlation with bathymetry are

detected. Measurement of surface elevation for large lakes, lakes smaller than the altimeter footprint, and rivers, all to a precision of 1m or better, and an accuracy limited either by the satellite orbit ephemeris or by the knowledge of the elevation of a suitable reference surface are demonstrated. Data show that even small areas of exposed water can dominate terrain backscatter. The detection of ocean-like echo waveforms from desert areas, and the ability of the altimeter to provide a measure of dune height and to map desert zonation are noted. ESA

**N88-11209*#** National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, Va.
**AIRBORNE LIDAR EXPERIMENTS AT THE SAVANNAH RIVER PLANT**
William B. Krabill and Robert N. Swift (EG and G Washington Analytical Services Center, Inc., Wallops Island, Va.) Washington NASA Jun. 1985 97 p
(NASA-TM-4007; NAS 1.15:4007; DOE/SR/14075-1) Avail: NTIS HC A05/MF A01 CSCL 08B

The results of remote sensing experiments at the Department of Energy (DOE) Savannah River Nuclear Facility utilizing the NASA Airborne Oceanographic Lidar (AOL) are presented. The flights were conducted in support of the numerous environmental monitoring requirements associated with the operation of the facility and for the purpose of furthering research and development of airborne lidar technology. Areas of application include airborne laser topographic mapping, hydrologic studies using fluorescent tracer dye, timber volume estimation, baseline characterization of wetlands, and aquatic chlorophyll and photopigment measurements. Conclusions relative to the usability of airborne lidar technology for the DOE for each of these remote sensing applications are discussed. Author

## 44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

**N88-11210#** Squires Labs., Las Cruces, N. Mex.
**DEVELOPMENT OF AN INNOVATIVE, LOW-COST SOLAR COLLECTOR Final Report, 30 Jan. 1986 - 30 Apr. 1987**
M. P. Squires Jun. 1987 80 p Sponsored by New Mexico Research and Development Inst., Santa Fe
(PB87-206819; NMRDI-2-74-4625) Avail: NTIS HC A05/MF A01 CSCL 10A

A low cost domestic water heating system, one that could be sold at a retail price of $500, was developed and produced. The primary effort was to reduce solar collector plate costs and, more specifically, the collector absorber plate costs. Plastic adhesive research resulted in the extensive use of silicone adhesives in a high performance solar collector which was also durable, reliable and easy to manufacture at a low cost. High thermal performance resulted from development of a silicone based conductive bond. The new collector has full pressure capability, and can be manufactured in quantity at a materials cost of $55 and a labor cost of $3.35. Detailed design descriptions, drawings, and photographs, of four different low cost solar collectors that were designed and built are included. Also, material listings and a step-by-step procedure for manufacturing the selected collector are included. NMSEI Performance Data for the new collector are compared to the certification data of the model SL-100 collector previously manufactured by American Solar Products. Author

**N88-11211#** Volunteers in Technical Assistance, Inc., Arlington, Va.
**UNDERSTANDING PASSIVE COOLING SYSTEMS**
Daniel Halacy 1986 29 p
(PB87-210464; VITA/TP-48:6/86; ISBN-0-86619-265-4)
Copyright Avail: NTIS HC A03/MF A01 CSCL 10A

The history of passive cooling, basic theory, cold reservoirs, sun shading, reflection of solar heat, ground cooling, wind cooling, water cooling, evaporative cooling, night cooling of thermal mass, exotic passive cooling methods, arid and humid climate technologies, and the future of passive cooling are explained. GRA

**N88-11212#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.
**THE PREPARATION OF THIN FILMS FOR PHOTOVOLTAIC CONVERSION BY NOVEL MOCVD TECHNIQUES Final Subcontract Report, Mar. 1987**
A. Saunders, G. Tyrrell, and A. Vecht (Phosphor Consultants, London, England ) Jun. 1987 57 p
(Contract DE-AC02-83CH-10093)
(DE87-001185; SERI/STR-211-3173) Avail: NTIS HC A04/MF A01

Details are presented for the chemical vapor deposition of a range of thin film materials for potential photovoltaic device applications. It is shown that the CVD/MOCVD approach is capable of yielding thin films of ZnO(In), Zn sub x Cd sub 1-x/S (In), and the binary and ternary sulfides and selenides of copper and indium. In addition to the presentation of essential deposition conditions, structural and compositional data are given and, where applicable, optical and electrical characteristics. DOE

**N88-11213#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.
**DTA/DSC STUDIES OF PHASE EQUILIBRIA IN BINARY MIXTURES OF BARIUM CARBONATE WITH ALKALI CARBONATES**
Roger E. Mills (Louisville Univ., Ky.) and R. Thomas Coyle Jul. 1987 55 p
(Contract DE-AC02-83CH-10093)
(DE87-001195; SERI/TR-255-2993) Avail: NTIS HC A04/MF A01

Phase diagrams for binary mixtures of BaCO3 with K2CO3, Na2CO3, or Li2CO3 have been prepared using data for melting enthalpies and temperatures obtained from differential thermal analysis experiments. The information will contribute to determining if BaCO3 is acceptable as a partial replacement for Li2CO3 in mixtures of these carbonates used as heat transfer and storage media in central solar receivers. DOE

**N88-11214#** Sandia National Labs., Albuquerque, N. Mex.
**THE FUNDAMENTALS OF PHOTOVOLTAIC SYSTEM ELECTRICAL DESIGN**
David Menicucci and Thomas Key 1987 17 p Presented at the American Solar Energy Society Annual Meeting, Portland, Oreg., 1 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-009061; SAND-87-0162C-FP; CONF-8706101-1; CONF-870711-2-FP) Avail: NTIS HC A03/MF A01

Over the past ten years research and development has led to the successful design and construction of many terrestrial photovoltaic (PV) systems. Much attention has been given to new and better designs for photovoltaic arrays and other system components. However, the design for electrical subsystems has evolved more on a case-by-case basis and no attempt has been documented to develop a standardized approach. This paper combines unique PV field experience with proven electrical design practices to provide fundamental design guidance for wiring, grounding and protection of photovoltaic power systems. Design criteria are identified and electrical subsystem design practices are recommended for several classes of residential, commercial, and industrial PV applications. DOE

**N88-11215#** Spire Corp., Bedford, Mass.
**GALLIUM ARSENIDE AND MULTIBANDGAP SOLAR CELL RESEARCH Final Subcontract Report, Apr. 1984 - Apr. 1986**
S. M. Vernon, S. P. Tobin, and R. G. Wolfson Jul. 1987 54 p

Prepared for Midwest Research Inst., Golden, Colo.
(Contract DE-AC02-83CH-10093)
(DE87-012260; SERI/STR-211-3188) Avail: NTIS HC A04/MF A01

This report presents results of research in high-efficiency, low-cost solar cells, emphasizing heteroepitaxial growth of a III-V compound material onto a single-crystal silicon wafer. The report describes the start-up and characterization of a new metal-organic vapor deposition (MOCVD) reactor for the growth of GaAs, GaAlAs, and GaAsP on 2-in.-diameter substrates with excellent uniformity; optimization of the growth of Ge films on Si by a simple CVD technique; and production of a 9% efficient GaAs-on-Ge-on-Si solar cell. The advancements in the understanding of the GaAs-on-Si growth process and in the quality of the films are described. The work also included production of a 7% efficient GaAs-on-Si cell; development of a GaAsP-on-GaAs growth technology; production of a 16.5% efficient GaAsP cell and a 17.7% efficient GaAlAs cell on GaAs; and production of a 20.8% efficient GaAs-on-GaAs cell. Also described are improvements in cell processing technologies, including the use of a double-layer antireflection coating. DOE

**N88-11216#** Stanford Univ., Calif.
**PREPARATION AND PROPERTIES OF EVAPORATED CdTe FILMS Final Subcontract Report, 16 Feb. 1985 - 31 Mar. 1987**
R. H. Bube, A. L. Fahrenbruch, and K. F. Chien Jul. 1987 51 p Prepared for Midwest Research Inst., Golden, Colo.
(Contract DE-AC02-83CH-10093)
(DE87-012270; SERI/STR-211-3190) Avail: NTIS HC A04/MF A01

Previous work on evaporated CdTe films for photovoltaics showed no clear path to successful p-type doping of CdTe during deposition. Post-deposition annealing of the films in various ambients thus was examined as a means of doping. Anneals were done in Te, Cd, P, and As vapors and in vacuum, air and Ar, all of which showed large effects on series resistance and diode parameters. With As, series resistance values of In/p-CdTe/graphite structures decreased markedly. This decrease was due to a decrease in grain boundary and/or back contact barrier height, and thus was due to large increases in mobility; the carrier density was not altered substantially. Although the series-resistance decreases were substantial, the diode characteristics became worse. The decreases were not observed when CdS/CdTe cells were fabricted on Te vapor-annealed films. Preparation of ZnO films by reactive evaporation yielded promising results. Deposition of p-ZnTe films by hot-wall vapor evaporation, using conventional techniques, yielded acceptable specimens. DOE

**N88-11217#** Argonne National Lab., Ill. Systems Engineering and Technology Group.
**ORGANIC RANKINE-CYCLE POWER SYSTEMS WORKING FLUIDS STUDY. TOPICAL REPORT NO. 1: FLUORINOL 85**
M. L. Jain, J. C. Demirgian, and R. L. Cole Sep. 1986 68 p
(Contract W-31-109-eng-38)
(DE87-014604; ANL/CNSV-TM-182) Avail: NTIS HC A04/MF A01

The thermal stability limits and degradation rates of Fluorinol 85 as a function of maximum cycle temperatures are determined. Following the design and construction of a dynamic test loop capable of simulating the thermodynamic conditions of possible prototypical organic Rankine-cycle (ORC) power systems, several test runs were completed. The Fluorinol 85 test loop was operated for about 3800 h at a temperature range of 525 to 600 F. Both liquid and noncondensable vapor (gas) samples were drawn periodically and analyzed using capillary column gas chromatography, gas chromatography/mass spectrometry and mass spectrometry. Results indicate that Fluorinol 85 would not decompose significantly over an extended period, up to a maximum cycle temperature of 550 F. However, 506-h data at 575 F show initiation of significant degradation. The 770-h data at 600 F, using a fresh charge of Fluorinol 85, indicate an annual degradation rate of more than 17.2%. The most significant degradation product observed is hydrofluoric acid, which could cause severe corrosion in an ORC system. Removal of the hydrofluoric acid and prevention of temperature extremes are necessary for an ORC system using Fluorinol 85 as a working fluid. DOE

**N88-11218#** Sandia National Labs., Albuquerque, N. Mex.
**SOLAR THERMAL TECHNOLOGY Annual Report, fiscal year 1986**
Jul. 1987 190 p Prepared in cooperation with Sandia National Labs., Livermore, Calif. and Midwest Research Inst., Golden, Colo.
(Contract DE-AC02-83CH-10093)
(DE87-001171; DOE/CH-10093/12) Avail: NTIS HC A09/MF A01

The research and development (R and D) described in this document was conducted within the US Department of Energy's (DOE) Solar Thermal Technology (STT) Program. This annual report is divided into two parts. Part 1 describes the accomplishments and progress of government-funded activities initiated, renewed, or completed during Fiscal Year (FY) 1986 (October 1, 1985, through September 30, 1986). It highlights the program tasks conducted by participating national laboratories and by contracting industrial, academic, or other research institutions. The focus of the STT Program during the year was research and development leading to the economic viability of two primary solar thermal concepts, central receiver and parabolic dish. Part 2 details the FY 1986 contract descriptions. These are followed by three appendices covering contacts, acronyms and abbreviations, a glossary, and a contractor index. A comprehensive bibliography of solar thermal technology publications is located after the appendices. DOE

**N88-11219#** Illinois Univ., Urbana. Coordinated Science Lab.
**CuInSe2 SOLAR CELL RESEARCH BY SPUTTER DEPOSITION Annual Subcontract Report, 1 Jan. - 31 Dec. 1986**
J. A. Thornton, T. C. Lommasson, and H. Talieh Jun. 1987 87 p Prepared in cooperation with Stanford Linear Accelerator Center, Menlo Park, Calif.
(Contract DE-AC02-83CH-10093)
(DE87-001184; SERI/STR-211-3174) Avail: NTIS HC A05/MF A01

This report contains results of research on CuInSe solar cells by sputter deposition. Most of the CuInSe/Cds devices fabricated from CuInSe deposited by reactive sputtering have been characterized by relatively low open-circuit voltages. Typical values range from 0.22 to 0.32 V. A contributing factor may be the lower In composition in the top layer of composite two-layer CuInSe films (Cu-rich base layer, In-rich top layer) that we used in cell fabrication. The reason for the lower In content is an In rejection process occurring during deposition at elevated temperatures. Therefore, the major emphasis of this work was to increase the In content in the top layer of CuInSe films deposited in composite two-layer configurations on Mo-coated, glass substrates. Variations in the relative currents to the Cu and In sputtering sources, the H Se injection rate, and the substrate temperature were explored. A temperature decrease from 450° to 400°C increased the In composition from 25 at. % to about 27 at. %. A second approach, in which the In sputtering source was operated for a short time with no Cu sputtering, also yielded promising results. DOE

**N88-11220#** Sandia National Labs., Albuquerque, N. Mex.
**PROCEEDINGS OF THE SOLAR THERMAL TECHNOLOGY CONFERENCE**
C. E. Tyner, ed. Aug. 1987 358 p Conference held in Albuquerque, N. Mex., 26 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-014441; SAND-87-1258; CONF-870875-Absts) Avail: NTIS HC A16/MF A01

The Solar Thermal Technology Conference was held on August 26 to 28, 1987, at the Marriott Hotel, Albuquerque, New Mexico. The meeting was sponsored by the United States Department of Energy and Sandia National Laboratories. Topics covered during the conference included a status summary of the Sandia Solar

Thermal Development Project, perspectives on central and distributed receiver technology including energy collection and conversion technologies, systems analyses and applications experiments. The proceedings contain summaries (abstracts and principal visual aids) of the presentations made at the conference. DOE

**N88-11221#** Sandia National Labs., Albuquerque, N. Mex.
**DIRECT ABSORPTION RECEIVER FLOW EXPERIMENTS**
J. M. Chavez, C. E. Tyner, and W. A. Couch 1 Sep. 1987 14 p
(Contract DE-AC04-76DP-00789)
(DE87-014655; SAND-87-1426) Avail: NTIS HC A03/MF A01

In a solar central receiver system Direct Absorption Receiver (DAR), the heat absorbing fluid (a blackened molten nitrate salt) flows in a thin film down a vertical panel (rather than through tubes as in conventional receiver designs) and absorbs the concentrated solar flux directly. To better understand flow phenomena in this type of receiver, we are conducting flow tests using water (because its flow properties are similar to molten salt) and a 3 MWt solar-heated DAR panel research experiment using salt. In this paper we discuss the results of the water flow testing, including manifold development, film stability, wave phenomena, and wind and natural convection effects on flow. In addition, we describe the design of the panel research experiment and planned testing. DOE

**N88-11222#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.
**DIRECT ABSORPTION RECEIVER (DAR) SYSTEMS ASSESSMENT**
J. V. Anderson, W. Short, T. Wendelin, and N. Weaver Aug. 1987 50 p
(Contract DE-AC02-83CH-10093)
(DE87-012277; SERI/TR-253-3162) Avail: NTIS HC A03/MF A01

The direct absorption receiver (DAR) represents a fairly significant departure from conventional salt-in-tube receiver technology and appears to offer substantial promise for future generations of receivers. The DAR concept involves absorbing the solar flux directly into a film of molten salt that flows in a thin film over a plate. Since the film absorbs most or all of the flux directly, the flux limits associated with tubular receivers can be relaxed substantially. This allows smaller and lighter receivers, which results in better thermal performance and lower capital costs. This report describes the results of an effort to analyze the effects of these factors on system performance and energy cost for both cavity type and external DAR configurations. The approach taken is to directly compare a central system with a DAR receiver and the same system with a salt-in-tube receiver. The results show about a 16% improvement in the thermal performance (annual energy delivered) of a cavity DAR system, while the cost estimate for the DAR indicates a reduction of over 50% in the cost of the receiver. These two effects combine to produce about an 18% reduction in the levelized cost of delivered energy when compared to a system with a conventional salt-in-tube receiver. DOE

**N88-11223#** Brookhaven National Lab., Upton, N. Y.
**TAPPING THE EARTH'S GEOTHERMAL RESOURCES: HYDROTHERMAL TODAY, MAGMA TOMORROW**
L. E. Kukacka 17 Dec. 1986 18 p
(Contract DE-AC02-76CH-00016)
(DE87-014718; BNL-52054) Avail: NTIS HC A03/MF A01

The paper discusses geothermal resources, what it is, where it is, and how to extract energy from it. The materials research activities at Brookhaven National Laboratory related to geothermal energy extraction are discussed. These include high-temperature, light-weight polymer cements, elastomers, biochemical waste processing techniques, and non-metallic heat exchanger tubing. The economics of geothermal energy is also discussed. DOE

**N88-11224#** Sandia National Labs., Albuquerque, N. Mex.
**AN EVALUATION OF THE LEC-460 SOLAR COLLECTOR**
J. W. Strachan Sep. 1987 23 p
(Contract DE-AC04-76DP-00789)
(DE88-000052; SAND-87-0852) Avail: NTIS HC A03/MF A01

The optical performance of the LaJet Energy Corporation's membrane faceted concentrator, Model LEC-460, was evaluated at Sandia National Laboratories, Albuquerque, using a fluxmapper, a device that measures flux intensity in the aperture plane of the collector with a movable Kendall radiometer. Three-dimensional flux intensity plots and flux contour maps were produced from the data, and numerical integration of the data was performed to obtain an estimate of the total integrated power into the aperture plane. The test results, normalized to a reference insolation value of 0.1 W/sqcm, indicated a peak flux of 172 W/sqcm and a total integrated power of 30.2 kW. The net efficiency of the collector in a clean mirror condition was estimated to be 77.4%. DOE

**N88-10996#** Joint Publications Research Service, Arlington, Va.
**FOCUSING SOLAR ENERGY COLLECTOR**
I. V. Baum and A. K. Nalitkin *In its* USSR Report: Engineering and Equipment 4 May 1987 p 97-101 Transl. into ENGLISH from Izvestiya Akademii Nauk Turkmenskoy SSR: Seriya Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk (Ashkhabad, USSR), no. 1, Jan. - Feb. 1986 p 28-31 (For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

# 45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

**N88-11225#** National Marine Fisheries Service, Woods Hole, Mass. Fisheries Center.
**NOAA'S (NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION'S) NORTHEAST MONITORING PROGRAM (NEMP): A REPORT ON PROGRESS OF THE FIRST FIVE YEARS (1979-84) AND A PLAN FOR THE FUTURE**
R. N. Reid, M. C. Ingham, and J. B. Pearce May 1987 155 p
(PB87-210100; NOAA-TM-NMFS-F/NEC-44) Avail: NTIS HC A08/MF A01 CSCL 13B

The Northeast Monitoring Program (NEMP) was initiated at the beginning of Fiscal Year (FY) 1980 (1 October 1979) by NOAA. The objective is to coordinate and focus monitoring and research activities of NOAA studies of the marine environment in coastal and offshore waters of the northeastern United States. The pilot phase of the NEMP was from FY80 through FY84. The four major research program components are: water quality; sediments and benthos; trace contaminants in tissues; and biological effects. GRA

**N88-11226#** Brookhaven National Lab., Upton, N. Y.
**COMPILATION AND ANALYSIS OF AIR QUALITY DATA IN SUPPORT OF ACID DEPOSITION RESEARCH Progress Report**
C. M. Benkovitz Sep. 1986 34 p
(Contract DE-AC02-76CH-00016)
(DE87-014428; BNL-40195) Avail: NTIS HC A03/MF A01

The objective was the compilation and initial analysis of a prototype unified data base of current aerometric data needed in support of acid deposition research. State agencies were contacted and pertinent information on station locations, parameters measured, methods used, etc., on their air quality obtained. A prototype data base was designed to include air quality observations from the States of New York, New Jersey and Pennsylvania covering the time period 1977 to present. DOE

**N88-11227#** Oak Ridge National Lab., Tenn.
**DETECTION OF VAPORS OF FLAMMABLE LIQUIDS IN AIR BY ATMOSPHERIC SAMPLING MASS SPECTROMETRY/MASS SPECTROMETRY Progress Report, 31 Mar. 1987**
S. A. McLuckey, G. L. Glish, K. G. Asano, and E. H. McBay Aug. 1987 146 p
(Contract DE-AC05-84OR-21400)

(DE88-000030; ORNL/TM-10506) Avail: NTIS HC A07/MF A01

The detection of vapors of flammable liquids by atmospheric sampling glow discharge ionization coupled with mass spectrometry/mass spectrometry (MS/MS) is described. An atmospheric sampling ionization source based on a glow discharge has been developed for ionizing trace organic molecules in ambient air. This ion source has been coupled with a tandem mass spectrometer consisting of a quadrupole mass filter and a time-of-flight analyzer. This ion source/spectrometer combination has been evaluated for detecting vapors of flammable liquids in the positive ion mode. The flammable liquids tested include inter alia alcohols, hydrocarbon solvents, and several hydrocarbon fuel mixtures. The hydrocarbon fuel mixtures were first characterized by gas chromatography/mass spectrometry using 70 eV electron impact ionization. Mass spectra using a glow discharge ionization source were acquired for all samples. MS/MS spectra were acquired for all of the major ions observed in the mass spectra. The mass spectra are described, as are some of the MS/MS spectra. Both mass spectra and MS/MS spectra are included in appendices. The approach has been found to provide both high sensitivity and high specificity for the detection of vapors of flammable liquids in ambient air. The limits of detection for most of the compounds studied is expected to be on the order of parts per billion or less. DOE

**N88-11228#** National Oceanic and Atmospheric Administration, Silver Spring, Md. Air Resources Lab.

**ECC (ELECTROCHEMICAL CONCENTRATION CELL) OZONESONDE OBSERVATIONS AT SOUTH POLE, ANTARCTICA DURING 1986**

W. D. Komhyr, P. R. Franchois, B. C. Halter, and C. C. Wilson May 1987 220 p

(PB87-207502; NOAA-DR-ERL-ARL-11) Avail: NTIS HC A10/MF A01 CSCL 04B

Atmospheric ozone vertical distributions, air temperatures, and wind speed and wind direction data are presented for 51 balloon ozone radiosonde soundings made at South Pole, Antarctica, in 1986. Atmospheric vertical ozone distribution measurements with electrochemical concentration cell (ECC) ozonesondes were made by the NOAA Air resources Laboratory at South Pole Station to study the ozone decrease indicated in Anarctica in recent years by Dobson spectrophotometer and satellite total ozone observations. GRA

**N88-11317#** Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.

**OPPORTUNITIES FOR NOWCASTING AIR POLLUTION EPISODES AND ACCIDENTAL TOXIC AND RADIOACTIVE RELEASES**

R. A. Pielke, M. D. Moran, M. Segal, D. A. Wesley, and T. B. McKee *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 463-470 (For primary document see N88-11239 02-47)

(Contracts NA-81-RAH-00001; RP-1630-53; DAAL03-86-K-0175) Avail: NTIS HC A99/MF A01; print copy avail. EPD, ESTEC, Noordwijk, The Netherlands Dfl 80

# 46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

**N88-11229#** California Univ., Berkeley. Lawrence Berkeley Lab.

**GRAVITY AND FAULT STRUCTURES, LONG VALLEY CALDERA, CALIFORNIA**

S. F. Carle and N. E. Goldstein Jul. 1987 9 p Presented at the Annual Meeting of Geothermal Resources Council, Sparks, Nev., 12 Oct. 1987

(Contract DE-AC03-76SF-00098)

(DE87-014117; LBL-23648; CONF-871024-15) Avail: NTIS HC A02

The main and catastrophic phase of eruption in Long Valley occurred 0.73 m.y. ago with the eruption of over 600 cu km of rhyolitic magma. Subsequent collapse of the roof rocks produced a caldera which is now elliptical in shape, 32 km east-west by 17 km north-south. The caldera, like other large Quarternary silicic ash-flow volcanoes studied, has a nearly coincident Bouguer gravity low. Earlier interpretations of the gravity anomaly have attributed the entire anomaly to lower density rocks filling the collapsed structure. However, on the basis of many additional gravity stations and supporting subsurface data from several new holes, a much more complex and accurate picture has emerged of caldera structure. From a three-dimensional inversion of the residual Bouguer gravity data we can resolve discontinuities that seem to correlate with extensions of pre-caldera faults into the caldera and faults associated with the ring fracture. Some of these faults are believed related to the present-day hydrothermal upflow zone and the zone of youngest volcanic activity within the caldera. DOE

**N88-11230#** Lawrence Livermore National Lab., Calif.

**PRODUCTION OF NO BY GALACTIC COSMIC RAYS AND LIGHTNING**

K. E. Grant and D. J. Wuebbles Jul. 1987 12 p

(Contract W-7405-eng-48)

(DE87-014613; UCID-21145) Avail: NTIS HC A03/MF A01

As part of the ongoing development of the LLNL 2-D Stratospheric Transport-Kinetics Model, values for NO production rates due to galactic cosmic rays (GCRs) and lightning have been calculated. With the combined NO production rates from GCRs and lightning included in the LLNL 2-D model, we compared our predicted NO(sub y) mixing ratios with those from LIMS (Limb Infrared Monitor of the Stratosphere) data and other models. Although our predicted NO(sub y) mixing ratios are lower than the LIMS data at 16 mb and 30 mb, our values at these pressures are generally higher and in better agreement with LIMS than are the corresponding mixing ratios from other models. Further research is needed on the sensitivity of these results to changes in model transport processes. DOE

**N88-11231*#** Tel-Aviv Univ. (Israel).

**ENHANCEMENT OF SURFACE-ATMOSPHERE FLUXES BY DESERT-FRINGE VEGETATION THROUGH REDUCTION OF SURFACE ALBEDO AND OF SOIL HEAT FLUX**

J. Otterman [1987] 30 p

(Contract NAS5-28085)

(NASA-CR-181442; NAS 1.26:181442) Avail: NTIS HC A03/MF A01 CSCL 04A

Under the arid conditions prevailing at the end of the dry season in the western Negev/northern Sinai region, vegetation causes a sharp increase relative to bare soil in the daytime sensible heat flux from the surface to the atmosphere. Two mechanisms are involved: the increase in the surface absorptivity and a decrease in the surface heat flux. By increasing the sensible heat flux to the atmosphere through the albedo and the soil heat flux reductions, the desert-fringe vegetation increases the daytime convection and the growth of the planetary boundary layer. Removal of vegetation by overgrazing, by reducing the sensible heat flux, tends to reduce daytime convective precipitation, producing higher probabilities of drought conditions. This assessment of overgrazing is based on observations in the Sinai/Negev, where the soil albedo is high and where overgrazing produces an essential bare soil. Even if the assessment for the Sinai/Negev does not quantitatively apply throughout Africa, the current practice in many African countries of maintaining a large population of grazing animals, can contribute through the mesoscale mechanisms described to reduce daytime convective precipitation, perpetuating higher probabilities of drought. Time-of-day analysis of precipitation in Africa appears worthwhile, to better assess the role of the surface conditions in contributing to drought. Author

**N88-11232#** Geological Survey, Denver, Colo.
**HISTORICAL CATALOG OF SOUTHERN GREAT BASIN EARTHQUAKES, 1868-1978**
Mark E. Meremonte and Albert M. Rogers 1987 206 p
(Contract DE-AI08-78ET-44802)
(DE87-014340; USGS-OFR-87-80) Avail: NTIS HC A10

This catalog is a collation of earthquake hypocenters, intensities, and magnitudes for the Southern Great Basin (SGB) for the period 1868-1978 prior to the operation of the SGB network. The data are drawn from many sources such as earlier non-instrumental reports for the oldest earthquakes in national catalogs, reports by university stations operated in California, Nevada, and Utah, and data collected by local and regional networks that were operated temporarily in limited areas of the SGB. The geographical boundaries are 35.6°-38.5° N., 114.5°-118.0° W. This area encloses a circle of about 160 km radius centered on NTS. The catalog includes both natural and man-made earthquake activity. Man-made events include aftershocks and cavity collapses (which occur following most NTS nuclear tests), mining blasts and high-explosive experiments, and induced seismicity due to the impoundment of Lake Mead. DOE

**N88-11233#** International Centre for Theoretical Physics, Trieste (Italy).
**ON THE THEORY OF THE MICHELSON-MORLEY EXPERIMENT IN THE EARTH'S GRAVITATIONAL FIELD**
Y. Z. Zhang Nov. 1986 8 p
(DE87-703077; IC-86/347) Avail: NTIS (US Sales Only) HC A02/MF A01

In this paper we discuss further the expected results for a Michelson-Morley-type experiment with one of the arms in the vertical direction in the Earth's gravitational field. It is shown from a dimensional analysis that the expected effect, in the case of the arms having length of the order of 1m, is the order of ml/R. This means that the expected fringe shift, if wavelength of light is 1 micron, is the order of 10 to the -10 power when the interferometer is rotated through 90. DOE

**N88-11234#** Chicago Univ., Ill.
**STRATOSPHERIC PARTICLES: SYNCHROTRON X-RAY FLUORESCENCE DETERMINATION OF TRACE ELEMENT CONTENTS**
S. R. Sutton and G. J. Flynn (State Univ. of New York, Plattsburgh.) 1987 27 p Presented at the Lunar and Planetary Science Conference, Houston, Tex., 16 Mar. 1987 Prepared in cooperation with Brookhaven National Lab., Upton, N.Y.
(Contract DE-AC02-76CH-00016)
(DE87-012482; BNL-39991; CONF-870396-5) Avail: NTIS HC A03/MF A01

The first trace element analyses on stratospheric particles using synchrotron X-ray fluorescence (SXRF) are reported. Cr, Mn, Fe, Ni, Cu, Zn, Ga, Ge, Se and Br were detected. Concentrations for chondritic particle U2022G1 are within a factor of 1.7 of CI for all elements detected with the exception of Br which is 37 times CI. Chondritic particle W7029*A27 is also near CI for Cr, Mn, Fe, Ni, Cu, Zn and Ge but enriched in Ga, Se, and Br by factors of 5.8, 3.5 and 8.4, respectively. The third particle of the cosmic dust class also showed high Br enriched relative to CI by a factor of 28. Br was also detected at a high level in an aluminum-rich particle classified as probable artificial terrestrial contamination but exhibiting a chondritic Fe/Ni ratio. Br was not detected in a fifth particle also classified terrestrial and exhibiting a crustal Fe/Ni ratio. If the high Br has a pre-terrestrial origin, the ubiquity of the effect suggests that a large fraction of the chondritic interplanetary dust particles derive from a parent body (bodies) not sampled in the meteorite collection. DOE

**N88-11235#** Danish Meteorological Inst., Copenhagen. Div. of Geophysics.
**NARSARSUAQ (GREENLAND) GEOPHYSICAL OBSERVATORY. MAGNETIC RESULTS, 1984 Progress Report**
1987 71 p
(ISBN-87-7478-281-9; ETN-87-90095) Avail: NTIS HC A04/MF A01

The results of the standard observations carried out at the magnetic laboratory during 1984 are presented. The measurements show hourly means of horizontal and vertical intensity and hourly means of magnetic declination. Diurnal extreme values and mean diurnal inequalities are also given. ESA

**N88-11236#** Technische Univ., Hanover (West Germany). Inst. fuer Meteorologie und Klimatologie.
**THE AIR FLOW ON HILLS FROM MODELS AND EXPERIMENTS Final Report, Dec. 1985**
Axel Michael Hoff and Gerd Tetzlaff Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 253 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie, West Germany
(BMFT-FB-T-86-175; ISSN-0340-7608; ETN-87-90787) Avail: NTIS HC A12/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 41.50

The structure of the boundary layer over a nearly two-dimensional hill with a crest height of 110m was studied. The results comprise data on the mean wind flow and the characteristic changes in turbulence. Comparisons with theoretical models show that the depth of the friction layer on the hill is generally overestimated. ESA

**N88-11237#** Deutsches Geodaetisches Forschungsinst., Munich (West Germany).
**STUDY OF A SATELLITE-TO-SATELLITE TRACKING GRAVITY MISSION Final Report**
Paris, France ESA Mar. 1987 323 p Prepared in cooperation with Technische Univ., Munich, Federal Rep. of Germany and Technische Hogeschool, Delft, Netherlands
(Contract ESTEC-6557/85-NL-PP(SC))
(ESA-CR(P)-2419; ETN-87-90881) Avail: NTIS HC A14/MF A01

Use of the POPSAT and GRM satellites to acquire Earth gravity data through satellite-to-satellite tracking (SST) was assessed. Relative orbit plane geometries and related length and distribution of SST tracking periods; impact of orbit errors on the gravity field recovery and GRM orbit determination errors resulting from SST and groundstation tracking data; and intersatellite tracking system accuracy requirements for high resolution gravity recovery were studied. Results served as input data for a deterministic gravity recovery simulation from SST data of the high-low and the low-low links. The recovery simulation was restricted to a set of 200 1 deg x 1 deg gravity anomalies in a 10 deg x 20 deg regional area. With an intersatellite range-rate accuracy of +/- 10 micron/sec, 1 deg x 1 deg gravity anomalies can be derived with an rms error of 2.5 mgal from high-low SST data over a 6 months experiment duration. ESA

**N88-11238#** Illinois Inst. of Tech., Chicago.
**SITING AND GEOTECHNICAL PROGRAM FOCUS AND DIRECTIONS. REPORT UPON THE DELIBERATIONS OF A WORKSHOP HELD AT THE ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO, ILLINOIS ON AUGUST 4-5, 1986**
S. K. Saxena 1986 185 p Workshop held in Chicago, Ill., 4-5 Aug. 1986
(Contract NSF ECE-86-12728)
(PB87-206272; NSF/ENG-86050) Avail: NTIS HC A09/MF A01 CSCL 08K

The report reviews the status of the Siting and Geotechnical Systems Area of the Earthquake Hazard Mitigation Program, and recommends future directions for research in the area. Participants at the workshop were divided into four working groups concentrating on the following topics: (1) soil and rock properties and constitutive laws; (2) ground motion predictions and the effects of soil conditions on near surface motions, and the influence of soil properties on ground failure hazards; (3) ground motion measurements, arrays, and instrumentation; and (4) soil-structure interaction and design aspects. GRA

**N88-11254#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.
**HORIZONTAL SHAPE MATCHING APPLIED TO VAS DATA**
Daniel Birkenheuer *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 91-95 Sponsored by the Cooperative Inst. for Research in the Atmosphere and Colorado State Univ., Fort Collins (For primary document see N88-11239 02-47)
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**N88-11255#** Laboratoire de Meteorologie Dynamique du CNRS, Palaiseau (France).
**ANALYSIS OF THICKNESS FIELDS RETRIEVED FROM NOAA-7 OBSERVATIONS THROUGH THE 31 (IMPROVED INITIALIZATION INVERSION) METHOD. INTEREST FOR WEATHER FORECASTING**
A. Chedin, N. A. Scott, J. Flobert, N. Husson, C. Levy, G. Rochard, J. Quere, B. Bellec, and J. Simeon (Direction de la Meteorologie Nationale, Paris, France ) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 97-101 (For primary document see N88-11239 02-47)
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**N88-11309#** Naval Environmental Prediction Research Facility, Monterey, Calif.
**DEVELOPMENT AND TESTING OF AN AIR-MASS TRANSFORMATION TRAJECTORY MODEL**
Stephen D. Burk and Rolf H. Langland *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 419-422 (For primary document see N88-11239 02-47)
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# 47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

**N88-11239#** European Space Agency, Paris (France).
**MESOSCALE ANALYSIS AND FORECASTING: INCORPORATING NOWCASTING**
Bruce Battrick, ed. and Erica Rolfe, ed. Aug. 1987 711 p Symposium held in Vancouver, British Columbia, 17-19 Aug.; sponsored by the International Association of Meteorology and Atmospheric Physics, WMO, and ESA
(ESA-SP-282; ISSN-0379-6566; ETN-87-90867) Copyright Avail: NTIS HC A99/MF A01; print copy avail. EPD, ESTEC, Noordwijk, The Netherlands Dfl 80

The needs and benefits of mesoscale weather information; mesoscale analysis and forecasting; numerical weather prediction; and the use of mesoscale data in mesoscale numerical models were discussed. For individual titles, see N88-11240 through N88-11353.

**N88-11240#** Meteorological Office, Bracknell (England).
**APPLICATIONS AND BENEFITS OF SHORT PERIOD WEATHER FORECASTS**
C. R. Flood *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 3-6 (For primary document see N88-11239 02-47)
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The applications of short period and mesoscale weather information and the benefits from such weather services are examined. The overall system, including the link with customer, is considered. ESA

**N88-11241#** Hydrometeorological Inst. (Czechoslovakia).
**NOWCASTING FOR THE NATIONAL ECONOMY NEEDS**
D. Podhorsky *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 7-11 (For primary document see N88-11239 02-47)
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The use of nowcasting methods in Czechoslovakia to improve the cost-efficiency of harvest dispatching activities, of the coordination of road and railway maintenance during the winter, and of services for air traffic control is described. Case studies based on processing of primary radar and satellite data complemented with classical observations are presented. ESA

**N88-11242#** Osservatorio Ticinese, Locarno-Monti (Switzerland).
**COST-73 AND ITS APPLICATION IN VERY SHORT RANGE FORECASTING**
H. P. Roesli, J. Joss, and C. G. Collier (Meteorological Office, Bracknell, England ) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 13-18 (For primary document see N88-11239 02-47)
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The COST-73 research project on weather radar networking is described. Maritime weather, (flash-)floods and avalanches, inclusion of radar-derived obsevations in basic data set of mesoscale analysis and modeling schemes, and wet deposition (acid rain, nuclear fall-out) are covered. ESA

**N88-11243#** Washington Univ., Seattle. Dept. of Atmospheric Sciences.
**AN ILLUSTRATIVE EXAMPLE OF THE NOWCASTING CHALLENGE**
Peter V. Hobbs *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 21-23 (For primary document see N88-11239 02-47)
(Grant NSF ATM-83-11147)
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It is shown that, despite access to excellent real-time mesoscale data, nowcasting in the Genesis of Atlantic Lows Experiment (GALE) left much to be desired. The role of physical (or conceptual) models in nowcasting is discussed in the light of a case study from GALE. ESA

**N88-11244#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.
**MESOSCALE FORECASTING TODAY AND TOMORROW: PROBLEMS AND OPPORTUNITIES. A POSITION PAPER**
Thomas W. Schlatter *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 25-29 (For primary document see N88-11239 02-47)
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Prospects for subjective mesoscale forecasting in the United States are surveyed. The major opportunities are in the form of proliferating data sources; computing hardware for storing, analyzing, and displaying the data; and programs which focus on major improvements in mesoscale forecasting within the next 5 yr such as STORM and AWIPS-90. The outstanding problems are how to integrate diverse sources of data and cope with the glut of information; how to improve understanding of the interactions between mesoscale and other scales of motion; and how to educate forecasters. The UNIDATA program is helping universities strengthen curricula in mesoscale meteorology. ESA

**N88-11245#** National Center for Atmospheric Research, Boulder, Colo.
**NEW NOWCASTING OPPORTUNITIES USING MODERN METEOROLOGICAL RADAR**
Robert J. Serafin *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 35-41 Sponsored by NSF (For primary document see N88-11239 02-47)
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The use of Doppler radar for the measurement of low-level wind shear; quantitative measurement of the properties of clear-air boundaries and their relationship to the initiation of convective storms; and the use of multiparameter radar measurements for the real-time detection of hydrometeor phase, for the discrimination of hail from rain, and for quantitative precipitation measurements are discussed. Expert systems, information systems, and display devices are considered. ESA

**N88-11246#** National Center for Atmospheric Research, Boulder, Colo.
**NOWCASTING MICROBURSTS USING DOPPLER RADAR IN A FORECASTER-COMPUTER ENVIRONMENT**
Rita D. Roberts and James W. Wilson *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 43-48 Sponsored by NSF (For primary document see N88-11239 02-47)
(Contract DTFA01-82-Y-10513)
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Procedures to allow the forecaster to readily view radar reflectivity and Doppler velocity information in unprocessed and analyzed form and to identify signatures which precede microburst occurrence for a given storm reflectivity category are discussed. The forecaster applies physical understanding of the phenomenon to interpretation of the data and directs the computer to make specific calculations. Results are displayed in near real-time in a format for easy and quick interpretation. This forecaster-computer mixture provides an environment where the most rapid progress can be made toward a completely automated technique for nowcasting microbursts. ESA

**N88-11247#** Atmospheric Environment Service, Toronto (Ontario). Weather Center.
**USE OF A 5 CM DOPPLER RADAR TO DETECT AND FORECAST SEVERE THUNDERSTORMS IN A REAL TIME FORECAST OPERATION**
Michael J. Leduc and Paul Joe *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 49-54 (For primary document see N88-11239 02-47)
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Eleven severe weather events which occurred within range of the Doppler radar are examined. The storms were all nontornadic except for one. Warning probabilities of detection and lead times using conventional radar are compared to scores obtained incorporating Doppler radar. Ideal scores are postulated given use of Doppler data. Examples of rotation and convergence associated with reported damaging storms are presented. ESA

**N88-11248#** National Center for Atmospheric Research, Boulder, Colo.
**THUNDERSTORM NOWCASTING USING DOPPLER RADAR AND SOUNDINGS**
James W. Wilson and Cynthia Mueller *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 55-60 Sponsored by NSF and NOAA (For primary document see N88-11239 02-47)
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Data from 198 atmospheric soundings from 26 days during July are examined for their usefulness in nowcasting afternoon storm development. Earlier studies showed that storms were formed along convergence wind lines that could be observed by sensitive radars. It is shown that provided a sounding is taken close in time and space to a convergence line, computed stabilities are well correlated to the occurrence and intensity of resulting convection. Particularly useful is the technique of Foote (1984) which determines atmospheric stability at a variety of heights after being lifted by an obstacle such as a gust front. Unfortunately, time and space variations in the lower levels of the atmosphere are so large that the use of stability information is severely limited. For example, the lifted index from a noon sounding is poorly correlated to afternoon values within the 6000 sq km study area. ESA

**N88-11249#** Swedish Meteorological and Hydrological Inst., Norkoeping.
**A REAL-TIME SYSTEM FOR AUTOMATIC SINGLE-DOPPLER WIND FIELD ANALYSIS**
P. Ola G. Persson and Tage Anderson *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 61-66 (For primary document see N88-11239 02-47)
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An automatic system for the real-time conversion of single-Doppler radial wind velocities into standard meteorological wind field parameters was developed for short-range forecasting. Components include a dual pulse repetition frequency Doppler processing, the velocity azimuth display technique, and the uniform wind technique. An error source analysis was made to assess the wind field quality, and system outputs and their possible uses for nowcasting are discussed. ESA

**N88-11250#** National Center for Atmospheric Research, Boulder, Colo.
**THE USE OF ADVANCED DATA SETS IN THE SHORT-RANGE FORECASTING OF THE DEVELOPMENT OF A TORNADIC THUNDERSTORM ALONG A MESOSCALE CONVERGENCE ZONE**
Edward J. Szoke and Raymond H. Brady (National Oceanic and Atmospheric Administration, Boulder, Colo.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 67-72 Sponsored by NSF (For primary document see N88-11239 02-47)
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A difficult forecasting day from 26 July 85 in northeast Colorado, involving interaction among a variety of scales is described. The day begins with at best a moderate risk of nonsevere thunderstorms, but ends with intense thunderstorm development and an 18 min long tornado. A number of events come together to produce the unexpected development, including interaction among mesoscale outflow and stationary boundaries. Several experiments were underway at the time, providing an abundance of data, as well as forecasts from several sources. These allow for an evaluation of the possibility of real-time forecasting/nowcasting of such an event. ESA

**N88-11251#** National Oceanic and Atmospheric Administration, Norman, Okla. National Severe Storms Lab.
**DIAGNOSING SHORT TERM CHANGES IN TEMPERATURE AND MOISTURE PROFILES FROM SINGLE DOPPLER RADAR**
R. M. Rabin *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 73-78 (For primary document see N88-11239 02-47)
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A method to diagnose temperature and moisture changes aloft from single Doppler radar data and an initial radiosonde observation is outlined. The aim is to deduce changes in inversion strength and precipitable water between synoptic soundings, which is particularly important in forecasting thunderstorm initiation. Results of a test study are given. ESA

**N88-11252#** Wisconsin Univ., Madison. Cooperative Inst. for Meteorological Satellite Studies.
**IMPROVED GEOSTATIONARY SATELLITE SOUNDINGS FOR THE MESOSCALE WEATHER ANALYSIS/FORECAST OPERATION**
W. L. Smith, H. E. Revercomb, H. M. Woolf, H. B. Howell, D. LaPorte, and K. Kageyama (Sony Corp., Tokyo, Japan ) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 79-83 (For primary document see N88-11239 02-47)
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The theoretical basis for performing the interferometer modification to the GOES filter radiometer is outlined. Empirical results from airborne tests of the High-resolution Interferometer Sounder (HIS) are presented to demonstrate the remarkable vertical and horizontal resolving power of the interferometer sounder.

Because of its vertical resolution and accuracy, the HIS interferometer on a GOES satellite will help satisfy the requirements of thermodynamic sounding for mesometeorological analysis and forecasting. The modified GOES sounder will provide more accurate measurements of cloud altitudes and atmospheric soundings beneath thin and/or broken cloud than is achievable from low spectral resolution infrared filter radiometers. Observing the infrared spectrum in detail will also provide concentrations of atmospheric gases such as ozone and methane, and the thermal emission state of the land and sea surface. ESA

**N88-11253#** National Weather Service, Silver Spring, Md. Techniques Development Lab.

**VAS PRODUCTS AS INDICES OF THUNDERSTORMS AND SEVERE LOCAL STORM POTENTIAL**

David H. Kitzmiller and Wayne E. McGovern *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 85-90 (For primary document see N88-11239 02-47)

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The utility of GOES atmospheric sounder (VAS) derived thunderstorm predictors was compared with predictors derived from radiosonde observations and numerical forecasts. Comparisons among the VAS-derived predictors show that versions of the classic K index and precipitable water possess the greatest information with respect to general thunderstorm occurrence. The 50-kPa gradient wind speed (calculated from geopotential heights) and the 70 to 50 kPa temperature lapse rate are the best predictors for discriminating between situations that produce only general thunderstorm activity and those that produce severe local storms (e.g., tornadoes, large hail). Stability and moisture indices derived from the VAS retrievals possess more information than the same indices derived from concurrently-available radiosonde data or from the retrieval first-guess field. ESA

**N88-11254#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.

**HORIZONTAL SHAPE MATCHING APPLIED TO VAS DATA** **c46**

Daniel Birkenheuer *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 91-95 Sponsored by the Cooperative Inst. for Research in the Atmosphere and Colorado State Univ., Fort Collins (For primary document see N88-11239 02-47)

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An analysis technique that combines less accurate satellite data having high resolution and good small-scale horizontal structure with sparse but accurate terrestrial measurements is presented. The resulting analysis maintains accuracy while providing detail; the best aspects of each data source are integrated. The technique is illustrated with scanned infrared satellite data and is shown to enhance analyses of the preconvective meteorological environment. ESA

**N88-11255#** Laboratoire de Meteorologie Dynamique du CNRS, Palaiseau (France).

**ANALYSIS OF THICKNESS FIELDS RETRIEVED FROM NOAA-7 OBSERVATIONS THROUGH THE 31 (IMPROVED INITIALIZATION INVERSION) METHOD. INTEREST FOR WEATHER FORECASTING** **c46**

A. Chedin, N. A. Scott, J. Flobert, N. Husson, C. Levy, G. Rochard, J. Quere, B. Bellec, and J. Simeon (Direction de la Meteorologie Nationale, Paris, France ) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 97-101 (For primary document see N88-11239 02-47)

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The improved initialization inversion method for the 3 dimensional analysis of the atmospheric structure from satellite obsevations (TIROS-N series) was applied to NOAA-7 data over Europe. The scenes selected correspond to complex meteorological situations and resulted in substantial errors in forecasting. One of the situations is presented. Comparisons between retrieved and operational (conventional) thickness charts show that the method is ready for operational use. ESA

**N88-11256#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.

**OPERATIONAL CLOUD-CLEARING TECHNIQUES OF VAS RADIANCE DATA**

John S. Snook *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 103-106 Sponsored by T.S. Infosystems, and the NOAA Operational VAS Assessment (NOVA) Project (For primary document see N88-11239 02-47)

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Three alternative cloud-clearing schemes for GOES radiometer data were developed and applied at the NOAA Program for Regional Observing and Forecasting Services (PROFS) histogram analysis, multispectral classification, and IR window channel-surface temperature comparison. Results show the window IR-surface temperature best suits PROFS' operational workstation requirements. ESA

**N88-11257*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**AUTOMATED DETECTION OF SEVERE THUNDERSTORMS USING GEOSYNCHRONOUS INFRARED DATA**

Robert F. Adler, Robert H. Woodward, and Robert A. Mack (General Sciences Corp., Laurel, Md.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 107-110 (For primary document see N88-11239 02-47)

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A procedure to identify thunderstorms from short-interval (5 min) GOES infrared (IR) data and to estimate their intensity (updraft strength) in an automated fashion is described. Thunderstorms are identified in the IR field by a simple pattern-recognition approach. For mature thunderstorms, two key parameters are used to estimate intensity: the amount of penetration above the neutral point and the occurrence (or not) of a cold-warm couplet in the IR TB field. Based on cloud model results, the amount of penetration is related to the maximum updraft speed, which is converted to an index. Application of the algorithm to a case study is presented. ESA

**N88-11258*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**THE COMBINED USE OF DIAGNOSED MESOSCALE FRONTOGENESIS AND SATELLITE IMAGERY IN FORECASTING SQUALL LINE FORMATION**

Paul Dorian (General Sciences Corp., Laurel, Md.), Steven Koch, E., and William C. Skillman *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 111-116 (For primary document see N88-11239 02-47)

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The appearance of a line of small cumulus congestus clouds along a cold front in conjunction with developing mesoscale clear zone immediately behind the front was used to infer the existence of a meso-Beta-scale frontogenetical circulation capable of squall line initiation. The very short-range forecasting (2 to 6 hr) capabilities of synthesizing GOES imagery with diagnostic frontogenesis analyses of conventional surface data to predict the precise location and time of formation of such convective activity is demonstrated. The observations support the frontogenesis hypothesis postulated by Koch (1984). ESA

**N88-11259#** Royal Netherlands Meteorological Inst., De Bilt.

**OBSERVATION OF THE DEVELOPMENT OF MESOSCALE SYSTEMS BY OPERATIONAL METEOROLOGICAL SATELLITES**

G. J. Prangsma, A. Chedin, N. Husson, N. A. Scott, J. Quere, and G. Rochard (Centre d'Etudes de Meteorologie Spatiale, Lannion,

France ) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 117-127 Sponsored by the Dutch National Remote Sensing Board, and the French Government (For primary document see N88-11239 02-47)
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During Oct-Dec 1986 for a total of 55 passages of the NOAA-9 satellite over the mid and east North-Atlantic ocean, TIROS operational vertical sounder (TOVS) data were routinely analyzed using the improved initialization inversion method. Mesoscale developments undetected in the synoptic obsevations were found. Often such developments are found to coincide with gradients in the vorticity of the thermal wind fields as derived from the TOVS data. The case of 12-13 October 1986 is described. ESA

**N88-11260#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.
**THE USE OF SATELLITE IR DATA IN THE ENHANCEMENT OF SURFACE THERMAL FIELDS**
John A. McGinley *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 123-128 (For primary document see N88-11239 02-47)
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Development, testing, and evaluation of a horizontal shape matching scheme to combine surface point observations with remotely sensed satellite radiances by exploiting the strength of each system to produce an improved analysis are outlined. A case study demonstrates how well a surface front may be resolved with this technique. The scheme is evaluated over 10 frontal cases and shown to reduce error in the temperature analysis. Compared to a standard univariate interpolation scheme, the effect of adding satellite data to a surface network is like doubling the number of point observations. ESA

**N88-11261*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**USE OF SIMULATED SATELLITE RADIANCES FROM A MESOSCALE NUMERICAL MODEL TO UNDERSTAND KINEMATIC AND DYNAMIC PROCESSES**
Michael Kalb, Franklin Robertson, Gary Jedlovec, and Donald Perkey (Drexel Univ., Philadelphia, Pa.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 129-134 (For primary document see N88-11239 02-47)
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Techniques by which mesoscale numerical weather prediction model output and radiative transfer codes are combined to simulate the radiance fields that a given passive temperature/moisture satellite sensor would see if viewing the evolving model atmosphere are introduced. The goals are to diagnose the dynamical atmospheric processes responsible for recurring patterns in observed satellite radiance fields, and to develop techniques to anticipate the ability of satellite sensor systems to depict atmospheric structures and provide information useful for numerical weather prediction (NWP). The concept of linking radiative transfer and dynamical NWP codes is demonstrated with time sequences of simulated radiance imagery in the 24 TIROS vertical sounder channels derived from model integrations for March 6, 1982. ESA

**N88-11262#** Oklahoma Univ., Norman. School of Meteorology.
**FORECASTING AND NOWCASTING CUMULUS CONVECTION WITH SOUNDINGS RELEASED FROM A STORM-INTERCEPT VEHICLE**
Howard B. Bluestein, Eugene W. McCaul, Jr., Gary R. Woodall, Gregory P. Byrd, and Robert L. Walko (Colorado State Univ., Fort Collins.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 135-139 Sponsored by National Severe Storms Lab. and the Univ. of Oklahoma Associates (For primary document see N88-11239 02-47)
(Grants NSF ATM-86-06090; NSF ATM-83-04374)
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The usefulness of upper air data from radiosondes for short-term forecasting and nowcasting was assessed. The sondes were released and tracked with an optical theodolite along the dryline in western Oklahoma during the springs of 1985 and 1986 by a storm-intercept automobile, which released the balloons. When the necessary conditions for convection based upon sounding data alone are not present, convection should not be expected. However, if they are present, they may not be sufficient for convective activity. The soundings appear to be most useful for eliminating days on which severe weather should be expected. ESA

**N88-11263#** Bureau of Reclamation, Auburn, Calif. Sierra Cooperative Pilot Project.
**STRUCTURE AND MODIFICATION OF WINTER MOUNTAIN CLOUDS IN THE SIERRA NEVADA: NOWCASTING/FORECASTING THE ONSET OF SUPERCOOLED LIQUID WATER**
David W. Reynolds *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 141-146 Submitted for publication Sponsored in part by the Bureau of Reclamation (For primary document see N88-11239 02-47)
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Midlatitude, cyclonic storms affecting the central Sierra Nevada are analyzed. Combining information from a vertically pointing microwave radiometer, conventional radar data, and satellite imagery in detailed time cross-sections of rawinsonde data, relationships between these different remote sensing devices and the onset of supercooled liquid water (SLW) are developed. Passage of an upper or surface cold front leads to decreasing cloud thickness, warm cloud top, and embedded convection producing the highest concentrations of SLW within a given storm. The frontal structures shown are consistent with those observed in the U.S. Pacific Northwest and the British Isles. Results of a forecast experiment conducted during two winter seasons to test forecastability of these events are highlighted. ESA

**N88-11264#** Meteorological Research Inst., Yatabe (Japan).
**A PROPOSAL OF THE NOWCASTING SYSTEM FOR SEA FOG**
Tetsuji Sawai, Masahito Ishihara, and Zenji Yanagisawa *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 147-152 (For primary document see N88-11239 02-47)
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A ground-based nowcasting system for sea fog, combining an 8.6 mm radar detecting directly fog distributions and the measuring techniques of vertical profiles of meteorological variables is proposed. It can detect the precursors of change of fog from the radar echo and the vertical profiles, and can be used in very-short-range forecastings for sea traffic facilities. ESA

**N88-11265#** Atmospheric Environment Service, Downsview (Ontario). Cloud Physics Research Div.
**NOWCASTING RAIN/SNOW TRANSITIONS AND FREEZING RAIN**
Ronald E. Stewart *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 155-161 Sponsored by the Federal Panel on Energy Research and Development (For primary document see N88-11239 02-47)
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The microscale and subcyclonic scale characteristics associated with precipitation types in winter storms are reviewed. Techniques employing satellite, radar, and surface observations for improving the nowcasting of precipitation types in winter storms are suggested. ESA

**N88-11266#** Royal Netherlands Meteorological Inst., De Bilt.
**FORECASTING THE KIND OF PRECIPITATION IN WINTER**
Ruud A. A. M. Ivens *In* ESA, Mesoscale Analaysis and Forecasting

Aug. 1987 p 163-166 (For primary document see N88-11239 02-47)
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In order to improve forecasts concerning the kind of precipitation, especially in cases with equal statistical probabilities of solid and liquid precipitation, a method using the vertical wet bulb temperature profile in the lower part of the atmosphere and the observed or expected amount of precipitation was developed. In the case of prolonged precipitation the method makes it possible to predict the change of liquid to solid precipitation in time. Especially for precipitation related to warm fronts, the method performs better than other statistical methods. ESA

**N88-11267#** Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
**ON THE ROLE OF SNOW IN THE REDISTRIBUTION OF PRECIPITATION BY SMALL SCALE TOPOGRAPHY**
Wojciech W. Grabowski *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 167-171 (For primary document see N88-11239 02-47)
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A seeder-feeder model in which a large scale seeder cloud is modified by small scale airflow perturbations is proposed. Bulk microphysics parameterization and coordinate transformation are used. It is shown that airflow perturbations near melting level are crucial for precipitation distribution in complex terrain since snow responds faster to the changes in the environmental conditions than rain does. Comparisons of simple simulations with field measurements are presented. ESA

**N88-11268#** Pike (W. S.), Newbury (England).
**THE 54-HOURS CONTINUOUS POST-FRONTAL PRECIPITATION NORTH OF THE ALPINE MOUNTAIN BARRIER, 22-25 AUGUST 1975**
W. S. Pike *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 173-176 (For primary document see N88-11239 02-47)
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Post-frontal precipitation (PFP) produces rainfall totals of 120 mm north of the Alps, over a 10 km x 160 km - long area, with 54-hr lighter PFP close to the event's northern limit. Large thermal contrast produces an active frontal zone containing two merging cold fronts, with cool, polar maritime replacing hot, continental air. Alpine lee-cyclogenesis, with a 500 mbar cut-off low development extending the upwind trough, effectively arrests frontal progress southeastwards near the Alps. The PFP is enhanced by upper and lower airflows acting in opposition causing return spread of frontal (and seeder precipitation) in southerlies above thick, low (feeder) cloud forming below in cool northerlies, in part blocked and subject to uplift towards the barrier. The PFP continues while the quasi-stationary frontal surface hovers temporarily at wind-shear level between upper and lower airflow. A 48 hr PFP upstream of a mountain-barrier in Canada is compared. ESA

**N88-11269#** Pike (W. S.), Newbury (England).
**LONGER-DURATION POST-FRONTAL PRECIPITATION AT VANCOUVER INTERNATIONAL AIRPORT, 1953-1983**
W. S. Pike *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 177-181 (For primary document see N88-11239 02-47)
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Vancouver's situation upwind of mountain barriers is shown to be significant in producing longer-duration post frontal precipitation with flow-blocking, wind-shear, and orographic-uplift playing their parts. Listing 75 events over 31 yr, frequency maxima are found during the seasonal changeovers of late-spring and late-autumn. Noted are surface and 500 mbar features (above Western Cordillera-top height) with cut-off low formation at 500 mbar level occurring nearby and probably influencing 4 of the longest 5 events, including the exceptional 48 hr rainfall of 14-16 May 1959. During this event, with an occlusion lying through a col area nearby, in very light low-level winds there was evidence from Carmi and Tatoosh Island ascents of a temporary but complete 180 deg wind-shear between 1500 m and 2000 m levels (i.e., near local mountain-top height). ESA

**N88-11270#** Central Weather Bureau (Taiwan).
**OBSERVATIONAL ANALYSIS OF THE INTERACTION BETWEEN FRONTS AND THE OROGRAPHY IN TAIWAN DURING THE LATE WINTER MONSOON SEASON**
Shih-ting Wang and Tsung-yao Wu *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 183-188 (For primary document see N88-11239 02-47)
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Mesoscale analysis of cold fronts past Taiwan during the late winter monsoon season is summarized. It is found that the mountain complex in Northern Taiwan can only cause the retardation and distortion of the monsoonal fronts, while the central mountain range (CMR) influences the fronts in different ways. These include: the breakdown of the approaching front into two parts due to differential propagation speeds; the mesoscale windward and leeward cyclogenesis are often initiated to the west and east sides of the CMR; sea breezes can trigger the mesoscale cyclogenesis either along the front or in the cold air behind the frontal zones; and the mesoscale frontogenesis can often occur to the east side of the CMR ahead of the synoptic scale front. ESA

**N88-11271#** Meteorological Research Inst., Tokyo (Japan).
**CONCEPTUAL MODELS OF BAIU FRONT AND BAIU FRONTAL DISTURBANCES IN MULTISCALE CHARACTERISTICS**
Takako Akiyama *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 189-194 (For primary document see N88-11239 02-47)
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Two synoptic scale conceptual models of the Baiu front stationary rainfall zone in East Asia in presummer are presented. The rainfalls are caused by interaction of various-scale disturbances. In the zonal situation, medium-scale (1000 km) cloud clusters develop in the frontal zone. Each cluster consists of a few mesoscale (100 km) echo systems. In the wave situation a medium-scale cloud band develops at the SW side of a synoptic-scale low. The band is a chain of a few mesoscale echo systems. The mesoscale echo systems in the medium-scale clusters and bands further consist of several convective echoes which repeat development and decay in the systems. ESA

**N88-11272#** Nanjing Univ. (China). Dept. of Atmospheric Science.
**THE NUMERICAL SIMULATION OF THE MESOSCALE CHARACTERISTICS ASSOCIATED WITH BAIU FRONT. PART 1: STRUCTURE, LOW-LEVEL JET AND RADIATION CHARACTERISTICS**
Shao-Yuan Wei *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 195-200 (For primary document see N88-11239 02-47)
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The mesoscale characteristics associated with Baiu fronts are simulated by a primitive equation model with 5 or 11 levels vertically, using mesoscale data for east China. The structural features are different at the various sections of a Baiu front. The polar front type structure of Baiu fronts is closely related to the existence of a cyclonic wave. The core of the low level jet corresponds to rainstorm regions. Radiation effects favor the occurrence and enhancement of convective precipitation. ESA

**N88-11273#** Deutscher Wetterdienst, Offenbach am Main (West Germany).
**THE IMPORTANCE OF MESOSCALE WAVES IN THE UPPER TROPOSPHERE FOR FORMATION OF CLOUD AND PRECIPITATION AREAS**
Manfred Kurz *In* ESA, Mesoscale Analysis and Forecasting

Aug. 1987 p 201-205 (For primary document see N88-11239 02-47)
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Examples of small cloud areas in satellite imagery are presented. The cloud areas are generally not correlated with any feature of the surface flow but occur within mesoscale waves in the mid and upper tropospheric current. The ascending motion leading to their formation is mainly forced by positive vorticity advection ahead of the wave troughs. Due to their small dimension the waves are frequently not well handled by numerical models. The best method for their forecasting is extrapolation with the aid of satellite images. ESA

**N88-11274#** Massachusetts Inst. of Tech., Cambridge. Center for Meteorology and Physical Oceanography.
**A ONE-DIMENSIONAL MODEL OF THERMALLY-DRIVEN COASTAL FRONT EVOLUTION**
John W. Nielsen *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 207-212 (For primary document see N88-11239 02-47)
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To investigate the stationary behavior of coastal fronts, a one-dimensional model was developed. The coastal front is assumed to be a density current parallel to the coastline whose speed is a function of the temperature difference across the front, the depth of the cold air, and the speed of the onshore flow. The temperature difference is generated by positive heat flux from the sea surface. The cold air depth is assumed constant and the onshore winds are specified. The model predicts the development of quasi-stationary coastal fronts for a wide range of air-sea temperature differences and ambient wind speeds. ESA

**N88-11275#** Bureau of Meteorology, Melbourne (Australia). Services Policy Branch.
**THE ROLE OF LOW-LEVEL COOLING IN A CONCEPTUAL MODEL OF THE AUSTRALIAN SUMMERTIME COOL CHANGE: IMPLICATIONS FOR VERY-SHORT-RANGE FORECASTING**
K. J. Wilson and B. F. Ryan (Commonwealth Scientific and Industrial Research Organization, Aspendale, Australia ) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 213-218 (For primary document see N88-11239 02-47)
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The prelandfall structure and temporal evolution of an Australian summertime cool change are examined. The major land-sea difference occurs in the prefrontal boundary layer where a strong surface maritime inversion is observed in offshore flow. The prefrontal region is characterized by deep ascent, low-level warm advection, and strong frontogenetic tendencies. Sensible heat budget residuals and time-height cross-sections at several stations are used to show that evaporation of precipitation is important in cooling the prefrontal subcloud layer, and results in the formation of a new prefrontal baroclinic zone. ESA

**N88-11276#** Bureau of Meteorology, Melbourne (Australia).
**AUSTRALIAN EAST COAST CYCLONES 3: CASE STUDY OF THE STORM OF AUGUST 1986**
Amanda H. Lynch *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 219-224 (For primary document see N88-11239 02-47)
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The explosively intensifying mesosynoptic scale cyclones which have the hurricane-like features of warm core, low-level wind maximum, and clear eyes, are described. These systems present a significant forecasting problem due to their rapid development and erratic motion, and are often so small as to slip through the observation network. A particularly violent case is chosen to examine the forecastability and dominant mechanisms of formation and intensification. It is shown that the system can be numerically predicted with reasonable skill. ESA

**N88-11277#** McGill Radar Weather Observatory, Ste. Anne de Bellevue (Quebec).
**ON THE INTERACTION BETWEEN RADAR AND SATELLITE IMAGE NOWCASTING SYSTEMS AND MESOSCALE NUMERICAL MODELS**
G. L. Austin, A. Bellon, P. Dionne, and M. Roch *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 225-228 (For primary document see N88-11239 02-47)
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The problem of allowing the output of mesoscale model predictions to modify the outcome of forecasts obtained by the extrapolation of radar and satellite imagery is addressed. It is shown that the mesoscale numerical models provide rather low scores in their quantitative predictions of precipitation. This is particularly apparent when allowance is made for the coarse spatial resolution of the models compared with the radar and satellite image extrapolation schemes. Mesoscale numerical weather prediction (NWP) schemes need to be initialized with high resolution rainfall and cloudiness data. The predictability of rainfall particularly at high spatial resolution and for times of a few hours should be investigated. It is possible that predictors derived from mesoscale NWP systems can improve the accuracy of rainfall estimates on time scales (CH110) 3 hr. ESA

**N88-11278#** Academia Sinica, Beijing (China). Inst. of Atmospheric Physics.
**A MINI SYSTEM FOR NOWCASTING**
Fengxian Zhou and Zhenhua Ma *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 229-232 (For primary document see N88-11239 02-47)
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A low cost hardware and software system based on IBM PC/AT for collecting, processing and displaying the conventional observations, weather radar, and meteorological satellite data in real time was developed. A linear method is used for predicting the radar echo movement. It is for operational use at local weather services for monitoring and forecasting severe weather such as strong wind, hailstones, thunderstorms, heavy rainfall, etc. Users can view the graphic and imagery products transmitted via telephone line or radio VHF (UHF) from main workstation on remote terminal or do own processing and display if raw data are brought over. ESA

**N88-11279#** Meteorological Office, Bracknell (England).
**FRONTIERS: AN OPERATIONAL SYSTEM FOR NOWCASTING PRECIPITATION**
B. J. Conway *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 233-238 (For primary document see N88-11239 02-47)
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The FRONTIERS interactive display system was developed for nowcasting. It uses images from a network of ground-based radars and from Meteosat to generate, every half-hour, analyses and very short period forecasts of precipitation. The original FRONTIERS development hardware was upgraded and duplicated to provide back-up for the operational machine and facilities for further development. Work continues to improve the speed and ergonomics of FRONTIERS, and to accommodate a rapidly growing network of radars. Interaction with the Meteorological Office's mesoscale numerical weather predictor model is planned, as is the use of expert system techniques to automate operator's judgemental and interpretive functions. ESA

**N88-11280#** Japan Meteorological Agency, Tokyo. Forecast Div.
**OPERATIONAL EXPERIMENT IN VERY SHORT RANGE FORECAST OF PRECIPITATION**
Y. Takemura, Y. Makihara, K. Takase, and K. Aonashi *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 239-244 (For primary document see N88-11239 02-47)

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A very short range forecasting scheme, and its performance during a heavy rainfall event are described. The scheme is based on extrapolation of precipitation observed by the initial time. The model gives fair results with changes of intensity. It overestimates precipitation amounts. ESA

**N88-11281#** Air Force Systems Command, Patrick AFB, Fla. Eastern Space and Missile Center.

**METEOROLOGICAL SYSTEMS SUPPORT TO CRITICAL SHUTTLE REQUIREMENTS ON THE EASTERN TEST RANGE**

B. F. Boyd, T. L. Wilfong, and R. C. Fleming *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 245-249 (For primary document see N88-11239 02-47)

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The major environmental factors affecting Shuttle operations and efforts to improve the observational and forecasting techniques to minimize those factors are outlined. Thunderstorms and upper level winds are the two major areas of concern, but atmospheric dispersion, visibilities, and low level winds also affect Shuttle operations. ESA

**N88-11282#** Pennsylvania State Univ., University Park. Dept. of Meteorology.

**SATELLITE IMAGERY AND CONCEPTUAL MODELS IN MESOSCALE FORECASTING**

Gregory S. Forbes, Kevin A. Degroodt, and Robert L. Scheinhartz *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 251-261 (For primary document see N88-11239 02-47)

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Examples of studies which incorporate satellite imagery and other conventional or remotely-sensed data for nowcasting and very short term weather forecasting are presented. One of the techniques merges a cloud-pattern steering technique and a statistical regression scheme for predicting modest changes in the cloud pattern during its translation. Conventional surface and upper air data are used in the regression equations. Another scheme uses satellite imagery to locate the position of maritime cold-air cloud clusters and then uses large scale meteorological data in their environments to predict whether or not they will intensify. ESA

**N88-11283#** Atmospheric Environment Service, Downsview (Ontario).

**EVALUATION OF THE RAINSAT PRECIPITATION ANALYSIS SYSTEM IN REAL-TIME USE**

Patrick King and Tsoi-ching Yip *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 263-268 (For primary document see N88-11239 02-47)

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Data from April to September are used to assess the performance of the Rainsat system for the analysis and short range forecasting of precipitation, beyond the range of the radar. Summary statistics for the whole period and for individual months are used to assess overall performance. Radar data and surface data are used to validate the Rainsat products. Rainsat uses a statistical relationship between visible and infrared brightness and rain detected by radar. This relationship was updated approximately monthly during the period of study. Comparisons between these relationship over periods of time illustrate the variability of the satellite/rain relationship over these time scales and in different synoptic situations. ESA

**N88-11284#** Atmospheric Environment Service, Bedford (Nova Scotia). Maritimes Weather Center.

**THE USE OF MCIDAS AS A MESOSCALE FORECASTING TOOL DURING THE CANADIAN ATLANTIC STORMS PROGRAMS**

J. D. Abraham *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 269-273 (For primary document see N88-11239 02-47)

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During the Canadian Atlantic Storms Program a forecast center was established for meteorological support to the project logistics committee. Short-term site-specific forecasts were prepared and meteorological systems evaluated. The Man-computer Interactive Data Access System (McIDAS) permitted access and looping of real time GOES satellite imagery, as well as other meteorological data. The GOES images were remapped to a polar-stereographic projection for use in short-term forecasting. Extrapolation techniques were employed, and color enhancements developed. The use of McIDAS enables one to better recognize, understand, and predict mesoscale processes involved in synoptic winter storms. ESA

**N88-11285#** Atmospheric Environment Service, Bedford (Nova Scotia). Maritimes Weather Center.

**A SHORT-RANGE FORECASTING EXPERIMENT CONDUCTED DURING THE CANADIAN ATLANTIC STORMS PROGRAM**

K. A. Macdonald, M. Danks, and J. D. Abraham *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 275-280 (For primary document see N88-11239 02-47)

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During the Canadian Atlantic Storms Program (CASP), a dedicated forecast center conducted experiments in mesoscale forecasting, in which several forecast products, including site-specific public and marine forecasts, were written every 3 hr. The forecasts were compared to a control set of forecasts. Precipitation forecasts prepared at the center are significantly better than the control. This improvement is attributed in large part to the Man-computer Interactive Data System workstation which the forecasters used. Due to a variety of limitations, verification statistics do not indicate that other weather elements are forecast any better during CASP. However, the results illustrate the need for careful design of mesoscale forecast systems. ESA

**N88-11286#** Atmospheric Environment Service, Vancouver (British Columbia).

**THE PACIFIC WEATHER CENTER SATELLITE FACILITY: AN OVERVIEW**

John Spagnol *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 281-286 (For primary document see N88-11239 02-47)

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A satellite reception and processing system for GOES data was commissioned for the Pacific Weather Center (PWC). The primary mission of the system is to assist in the meteorological analysis of data sparse areas within and upstream to the PWC area of responsibility. The products routinely produced in the operational environment of PWC utilizing the man/machine mix afforded by the METDAS system, and the assimilation of the product information into the forecast system are described. ESA

**N88-11287#** Bureau of Meteorology, Melbourne (Australia).

**THE CHALLENGE OF VERY SHORT RANGE FORECASTING IN THE TROPICS**

Greg J. Holland, Lance M. Leslie, Klaus Fraedrich, and Geoff B. Love *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 287-295 (For primary document see N88-11239 02-47)

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The status of very short range forecasting in the tropics is examined. Indications are that operational results are not as good as those obtained from simple climatological and persistence techniques, but that extra data, enhanced understanding, and better methods can produce significant improvements. Available data, technology, and communications are underutilized in tropical forecasting offices. A concept of an ideal forecasting system based on available people, data, and technology is suggested. It consists

of a network of specialized offices that the forecaster interacts with via a workstation. This workstation also helps manage the forecast routine and provides inbuilt expert training features.
ESA

**N88-11288#** Royal Netherlands Meteorological Inst., De Bilt.
**AN HOURLY ANALYSIS, UPDATING AND SHORT-RANGE FORECASTING SYSTEM**
L. C. Heijboer, H. Timmermann, and A. vanderHoek *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 297-301 (For primary document see N88-11239 02-47)
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An hourly analysis, updating, and very short-range forecasting system was developed using all available surface observations of pressure and wind over the North Sea and environment. Lateral boundaries and background fields are taken from the fine mesh UK-prognoses. The analyses and prognoses of pressure and wind are used for storm surge predictions. The winds of the analyses and forecasts are compared with the observations over The Netherlands and surrounding regions. In real time, they are also compared with those computed from the UK-prognoses. Results show a very good quality of the UK-prognoses. However, the hourly incorporation of observations gives improvements at least in the first hours of the forecast period. Storm surge computations for the Dutch coast demonstrate an advantage in favor of the hourly system.
ESA

**N88-11289#** Swedish Meteorological and Hydrological Inst., Norkoeping.
**SIMPLIFIED MODELS FOR USE IN AN OPERATIONAL SHORT RANGE FORECASTING SYSTEM**
S. Gollvik *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 303-306 (For primary document see N88-11239 02-47)
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Two models used for mesoscale forecasting are treated. The first is based on vorticity advection, featuring a scale separation between the vorticity and the advecting wind. A version of this model includes other processes, although on a larger scale. The two versions were compared with an ordinary synoptic scale forecast model. The second model is an air mass transformation model, which is a one-dimensional boundary layer model, advected along a trajectory, and influenced by upper and lower boundary conditions.
ESA

**N88-11290#** New Zealand Meteorological Service, Wellington.
**STATISTICAL VERY SHORT-RANGE FORECASTING VIA ANALOGUES**
Neil D. Gordon *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 307-312 (For primary document see N88-11239 02-47)
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A distance measure for analog weather forecasting is proposed. It is specific to the predictand(s) of interest, being based on a comparison of all pairs of observations in the historical record which are known to have similar values. Historical observations are entered into the analog set provided they have a large enough probability of being similar to the new observation. The analog set can then either provide direct predictions, or be used to calibrate separate forecasts (e.g., from linear regression). Results for two applications of the analog technique to very short-range forecasting of surface wind are presented.
ESA

**N88-11291#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.
**USE OF TIME CHANGES OF SURFACE DATA PARAMETERS IN SHORT RANGE FORECASTING**
J. McGinley, K. Runk, and J. Alleca (Air Force Global Weather Central, Offutt AFB, Nebr.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 313-319 (For primary document see N88-11239 02-47)
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Techniques to exploit the informational value of surface data are described. These consist of 2 to 3 hr wind vector changes, temperature changes, and dewpoint changes. Also included is low level advection of equivalent potential temperature which often points to areas of rapidly decreasing stability. By simple assumptions, the spatial variability of change fields can reveal discontinuities in capping layers, areas of strong evapotranspiration, and evidence of dynamic forcing. Case studies are presented.
ESA

**N88-11292#** National Weather Service, Silver Spring, Md. Techniques Development Lab.
**STATISTICAL REMOTE SENSING ALGORITHM DEVELOPMENT: A COMPLEMENTARY PROCESS TO MESOSCALE NUMERICAL MODELS**
Wayne E. McGovern *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 321-325 (For primary document see N88-11239 02-47)
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A local, short-range forecasting methodology (0 to 4 hr) to complement mesobeta scale (20 to 200 km) numerical modeling is presented. Remote sensing parameters can provide the necessary critical data for determining the evolution of an extreme event over its linear life-time. An example of this process, developed with quantitative radar reflectivity data, is demonstrated. Potential predictors from Doppler radar, lightning, and profiler systems capable of being applied in a similar, but eventually more integrated, statistical fashion are discussed.
ESA

**N88-11293#** Colorado State Univ., Fort Collins. Regional and Mesoscale Meteorology Branch.
**MESOSCALE THUNDERSTORM FORECASTING USING RAOB DATA, SURFACE MESONET OBSERVATIONS, AND AN EXPERT SYSTEM**
John F. Weaver and Roger S. Phillips *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 327-331 (For primary document see N88-11239 02-47)
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The use of an expert system on a personal computer for operational forecasting of severe weather and to train nonexpert users was assessed, using the CONVCTIV system (based on EXSYS). A test case shows that the expert system building convention of developing a knowledge base (through the collective and cooperative efforts of both the expert and a knowledge engineer) is viable for extracting and documenting a comprehensive collection of learned expertise about a meteorological subject. Translating that extracted knowledge into a knowledge base of rules is straightforward. Verification of pieces or subsets of knowledge prove to be similarly efficient. The efficacy of consistently applying the knowledge of CONVCTIV is clear. The IBM-AT easily accommodates EXSYS-CONVCTIV and particularly the external sounding analysis program. Interactive query/response times do not exceed the mind's comfort zone for attentiveness.
ESA

**N88-11294#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.
**A SEVERE WEATHER FORECAST SOFTWARE PACKAGE**
Steven C. Albers *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 333-338 (For primary document see N88-11239 02-47)
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A statistical package using synoptic and subsynoptic-scale data for a short-range forecast of severe weather probability over a grid in the south central United States was developed. Frequency

histograms are used to combine and transform the raw predictor variables into probabilities. The transformation reduces forecast bias. Once transformed, a regression equation linearly combines the transformed predictors to produce a severe weather forecast probability for each grid point. The most important raw predictors tested were the product of lifted index and surface wind divergence, storm-relative environmental helicity, and strength of the capping inversion. Predictors which are important but notably less effective include wind shear and moisture convergence. ESA

**N88-11295#** Guangzhou Meteorological Center (China).
**ANALYSIS OF SQUALL LINE BASED ON CONVENTIONAL DATA**
Dawen Huang *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 339-344 (For primary document see N88-11239 02-47)
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Based on the self-recording data from conventional surface stations over Pearl River Basin (China) a squall line process was analyzed. Results suggest that the times, when the squall line passes the stations are consistent with the occurrence of daily maximum wind speed there. Based on this relationship, 17 squall line cases are identified. Analyzing one type among them, favorable large-scale background conditions for squall line initiation are analyzed. ESA

**N88-11296#** Central Inst. for Weather Forecasting, Budapest (Hungary).
**DETAILED ANALYSIS OF A MESOSCALE CONVECTIVE COMPLEX SITUATION IN THE CARPATHIAN BASIN (EUROPE)**
E. Bodolai-Jakus, A. Kapovits, T. Taenczer, and F. Pinter *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 345-350 Sponsored by the Hungarian Academy of Sciences (For primary document see N88-11239 02-47)
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The weather conditions concerning the life-cycle of a mesoscale convective complex (MCC), very typical for those developing in the Carpathian basin in the special situations with no pressure gradient are discussed. Time series of digitized radar and satellite observations are used for the analysis. Mesoscale weather conditions for the convective systems appearing in the radar and satellite data fields are studied. It is found that convergence lines being permanently present in the friction layer, moist convective instability and orographic influence have a great role in the development and persistence of the MCCs in this case. ESA

**N88-11297#** Peking Univ. (China). Dept. of Physics.
**EFFECTS OF THE LARGE SCALE MOTION AND HORIZONTAL INHOMOGENEITY OF THE MOIST STATIC INSTABILITY ON DEVELOPMENT OF THE MESOSCALE CONVECTIVE SYSTEMS IN THE MIDLATITUDES**
Qiu-shi Chen *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 351-356 (For primary document see N88-11239 02-47)
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A mechanism of the development of mesoscale convective systems in midlatitudes is studied by a splitting method. It is found that if the moist static instability index is horizontally inhomogeneous with a mesoscale unstable region and air is nearly saturated, a coupling of the synoptic ascending motion with the mesoscale unstable region provokes a rapid growth of a mesoscale ascending motion through the unstable gravity-inertia waves. ESA

**N88-11298#** Guangzhou Meteorological Center (China). Inst. of Tropical Marine Meteorology.
**A REVIEW OF THE ANALYSIS FORECASTING AND RESEARCH ABOUT SEVERE LOCAL STORMS IN GUANGDONG PROVINCE (CHINA)**
Chengli Liang, Youxian Wei, Liangyan Deng, and Huixian Xue *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 357-362 (For primary document see N88-11239 02-47)
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Climatological features, synoptic pattern types, radar and satellite characteristics, forecasting procedures, and criteria for the severe local storms in Guangdong (China) are described. Severe local storms in Guangdong occur as early as January 16 and as late as October 3. The greatest frequency is in April, followed by August. About 13 cases per 10,000 km in Guangdong each year are reported. The events are classified into four main kinds of synoptic types based on the prevailing weather system, five kinds of cloud shape, and four kinds of echo. ESA

**N88-11299#** Academia Sinica, Beijing (China). Inst. of Atmospheric Physics.
**THE APPLICATION OF DIVERGENCE EQUATION IN THE ANALYSIS OF HEAVY RAINFALL**
Shu-qinq Sun *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 363-367 (For primary document see N88-11239 02-47)
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Terms of the divergence equation are used for the forecasting of heavy rainfall. Velocity divergence, vorticity, and geostrophic vorticity of real cases of heavy rainfall are calculated. A good relationship between the evolution of convergence and the development of mesoscale systems is found. Calculating the terms of the equation indicates that the change of divergence caused by nonlinear terms of horizontal wind is also important especially near the low level jet. Terms useful as predictors are given. ESA

**N88-11300#** Academia Sinica, Beijing (China). Inst. of Atmospheric Physics.
**THE STUDIES OF PHYSICAL MODELS ON HAILSTORMS AND THEIR APPLICATIONS IN NOWCASTING**
Ang-sheng Wang *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 369-374 (For primary document see N88-11239 02-47)
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An early simple nowcasting system for hail forecasts and hail suppression in China is described. Physical models of hailstorms were developed. Five classifications of Chinese hailstorms and their models, obtained from 230 hailstorms, are presented. The application of the models in nowcasting of hail and hail suppression is shown. ESA

**N88-11301#** Air Force Geophysics Lab., Hanscom AFB, Mass.
**CUMULUS AND THUNDERSTORM INITIATION BY MOUNTAINS**
R. Banta *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 375-380 Sponsored by AFOSR (For primary document see N88-11239 02-47)
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Factors affecting mountain thunderstorm initiation are analyzed using GOES satellite data and dynamic numerical cloud modeling. Using 3 summers of GOES data, over 600 thunderstorms were traced back to their initiation points in the Colorado mountains, to determine areas of repeated thunderstorm genesis. Genesis zone activity depends on the direction of the winds above the ridgetops, indicating upper-level wind direction to be a likely predictor of the location of mountain thunderstorm initiations. Other factors affecting cloud initiation were investigated using a two dimensioned mesoscale numerical model, including strength of ridgetop-level winds, magnitude of surface heat flux, and soil moisture content. Stronger winds aloft, lower surface heat flux, and higher soil moisture all inhibit mountain cloud-producing mechanisms. ESA

**N88-11302#** Oregon State Univ., Corvallis. Dept. of Atmospheric Sciences.
**STATISTICAL RELATIONSHIPS BETWEEN THE MESOSCALE ORGANIZATION OF CONVECTION AND THE LARGE-SCALE WIND PROFILES DURING GATE**
S. K. Esbensen and S. J. Desilva *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 381-386 (For primary document see N88-11239 02-47)
(Grant NSF ATM-84-14820)
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Radar and conventional upper-air data are combined to explore the statistical relationships between the mesoscale organization of precipitating clouds and large-scale wind field over the northeastern tropical Atlantic Ocean. Indices of the mesoscale organization of deep cumulus convection are developed through the application of a simple pattern recognition technique to radar estimates of precipitation. Time series of the indices are compared with the meso-alpha scale wind field over the area covered by the radar observations. Results are discussed in terms of their implications for forecasting and for the parameterization of the mesoscale effects of convective clouds in numerical models. ESA

**N88-11303#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**TOWARD OPERATIONAL FORECASTING AND DETECTION OF WEATHER-PRODUCING GRAVITY WAVES**
Steven E. Koch *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 387-392 (For primary document see N88-11239 02-47)
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Detecting (or nowcasting) mesoscale gravity waves whose horizontal wavelengths are 200 km or more is discussed. Synthesis of bandpass-filtered synoptic barograph data with geostationary satellite imagery sequences can accomplish this goal in an operational environment, but only if changes to the operational data collection and transmission systems are made. ESA

**N88-11304#** Atmospheric Environment Service, Winnipeg (Manitoba).
**THE IMPORTANCE OF THE LOWER LEVEL WINDSHEAR PROFILE IN TORNADO/NON-TORNADO DISCRIMINATION**
David Patrick and A. J. Keck *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 393-397 (For primary document see N88-11239 02-47)
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Multiple discriminant analysis was used to select the most significant predictors to distinguish between tornadic thunderstorms and nontornadic severe thunderstorms over the Canadian provinces of Saskatchewan, Manitoba, and the northwestern part of Ontario. An analysis of all 1986 severe thunderstorm data indicates that the tornadic storms can be broken down into 2 small groups and 1 larger group based on the storm environment. With the 2 smaller groups filtered out, the most significant predictors which discriminated between the tornadoes and nontornadoes are those which describe a medium-to-large veering arc in the windshear profile below 3 km above ground. ESA

**N88-11305#** State Univ. of New York, Albany.
**THE WINDSOR LOCKS, CONNECTICUT TORNADO OF 3 OCTOBER 1979: AN ANALYSIS OF AN INTERMITTANT SEVERE WEATHER EVENT**
Gary T. Riley and Lance F. Bosart *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 399-400 (For primary document see N88-11239 02-47)
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The history of an F4 tornado is traced by synoptic and subsynoptic scale analyses. Vigorous mid tropospheric ascent occurred just in advance of a cold core cutoff vortex that was opening up due to synoptic scale deformation while moving northeastward. The probable destabilization mechanism was the intersection of the northeastward moving pocket of cool air aloft with a tongue of high equivalent potential temperature surface air. Before and after the tornado the convective cell moved north-northeastward. Tornadogenesis occurred with the merger of this cell with an antecedent northeastward moving subsynoptic scale surface cyclone and surface warm frontal boundary. Immediately preceeding and accompanying tornadogenesis the cell turned left. A factor in the absence of severe weather watches was that radar indicated thunderstorm cloud tops were not penetrating the conventionally reported tropopause. Evidence that the actual tropopause was much lower near the vortex, and that the lapse rate definition of the tropopause needs to be modified, is presented. ESA

**N88-11306*#** National Oceanic and Atmospheric Administration, Boulder, Colo. Weather Research Program.
**SHORT-TERM FORECASTING OF LIGHTNING BASED ON THE SURFACE WIND FIELD AT KENNEDY SPACE CENTER**
Andrew I. Watson, Raul E. Lopez, Robert Ortiz, and Ronald L. Holle *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 401-406 Sponsored in part by NASA (For primary document see N88-11239 02-47)
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Cloud-to-ground lightning is related in time and space to surface convergence for 244 days during the summer over a 790 sqkm network. The method uses surface convergence, particularly the average over the area, to identify the potential for new, local thunderstorm growth, and can be used to specify the likely time and location of lightning during the life cycle of the convection. A threshold of 0.0000075/sec change in divergence is used to define a convergence event, and a separation of 30 min between flashes defines a lightning event. Time intervals are found to be on the order of 1 hr from beginning convergence to first flash, and (CH110) 2 hr from beginning convergence to the end of lightning. Major differences between the convergence-lightning relationships based on low-level mean onshore and offshore flow are noted. ESA

**N88-11307#** Royal Netherlands Meteorological Inst., De Bilt.
**FORECASTING BOUNDARY LAYER CLOUDS AND FOG: A REVIEW OF OPERATIONAL NUMERICAL MODELS**
J. Reiff *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 407-414 (For primary document see N88-11239 02-47)
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Three dimensional and air mass transformation models for forecasting atmospheric boundary layer (ABL) and fog are reviewed. For a reliable short-range model forecast of boundary layer clouds and fog, a good forecast of the daily cycle of the ABL and of the advection processes are required. For a forecast of the turbulent processes in the ABL many points in the vertical are required. An approach in which the horizontal resolution, vertical resolution, and size of the model domain does not pose a problem is the air mass transformation approach, in which a one-dimensional ABL-model is combined with trajectories. To describe the turbulent processes in the ABL, multilevel models have to be used. Bulk models may be used in forecasting a specific subset of ABL quantities, for instance the development of mature fog. ESA

**N88-11308#** Royal Netherlands Meteorological Inst., De Bilt.
**OPERATIONAL PRACTICE OF AN AIR MASS TRANFORMATION MODEL**
Dick Blaauboer *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 415-418 (For primary document see N88-11239 02-47)
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Operational results of and experiences with an air mass transformation (AMT) model, which consists of a three-dimensional trajectory part coupled with a one-dimensional model of the atmospheric boundary layer, are described. Verification results

show that the model can predict temperature and humidity at selected levels with a success comparable to that of the human forecaster (where the surface parameters are concerned) or the ECMWF-model (where the upper air parameters are concerned). The power of the AMT-model is more in the big vertical resolution in the predicted temperature/humidity profiles and the qualitative information in those profiles. As such the model largely supports the forecaster in making short-range forecasts. ESA

**N88-11309#** Naval Environmental Prediction Research Facility, Monterey, Calif.

**DEVELOPMENT AND TESTING OF AN AIR-MASS TRANSFORMATION TRAJECTORY MODEL** c46

Stephen D. Burk and Rolf H. Langland *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 419-422 (For primary document see N88-11239 02-47)

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A method of achieving high-resolution, short-range forecasts of atmospheric boundary layer (ABL) structure and properties with an inexpensive numerical model is described. The technique involves the coupling of a one-dimensional second-order closure ABL model to output from a regional model. Back trajectories are computed at each regional model level between the surface and 500 mb. The ABL model moves along the computed trajectory, with surface forcing specified at the highest resolution available. Differential advection is treated by conservative quantities advected along trajectories computed at upper levels. Detailed ABL structure develops during the course of the forecast due to surface forcing and other physical processes. ESA

**N88-11310#** Meteorological Office, Bracknell (England).

**FORECASTING STRATUS OVER THE BRITISH ISLES**

D. Mansfield *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 423-428 (For primary document see N88-11239 02-47)

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Statistics of the distribution of stratus over the United Kingdom are presented in terms of the variation at individual stations with local wind direction and season and in terms of the spatial distribution for different synoptic flow types. Three main regimes are discussed in relation to forecasting. Two summer regimes affecting the east and west coasts are largely associated with the advection of stratus formed by cooling over the sea. The third regime occurs in winter over most of central and eastern England and is probably due to cooling overland through moistening of the air during its passage across the North Sea or the English Channel. ESA

**N88-11311#** Technische Univ., Munich (West Germany). Inst. fuer Meteorologie.

**TWO-DIMENSIONAL NUMERICAL MODELING OF THE LIFE CYCLE OF FOG**

Renate Forkel, Uwe Sievers, and Wilford Zdunkowski (Mainz Univ., West Germany ) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 429-433 (For primary document see N88-11239 02-47)

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A two-dimensional numerical model for fog prediction in the mesoscale range is presented. Prognostic variables of the model are atmospheric temperature, total moisture content, aerosol concentration, wind field, and soil temperature. The liquid water content of fog is calculated diagnostically from the chemical equilibrium requirement between vapor and droplets. Radiative cooling rates are calculated using a two-stream method. To calculate the wind field a vorticity-streamfunction approach is used. Orography is accounted for by the use of a transformed vertical coordinate. Model calculations for an urban and rural region demonstrate the applicability of the model. The results show the delay of fog formation in the region of an urban island. The model accounts for the influence of water surfaces as well as inclined terrain on the life cycle of fog. ESA

**N88-11312#** Atmospheric Environment Service, Downsview (Ontario).

**MESOSCALE MOS FORECAST SUPPORT FOR 1988 WINTER OLYMPICS SKI EVENTS**

William R. Burrows *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 435-440 (For primary document see N88-11239 02-47)

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A model output statistics (MOS) wind and temperature forecast system is described. The forecasts are used to determine whether accurate forecasts of weather parameters on a scale of a few km in mountainous terrain can be generated by statistical methods using a numerical weather prediction model with a resolution of 200 km. The development data set and the forecasts to be provided are shown. Experiments involving the choices of data to be included for derivation of potential predictor sets are outlined. ESA

**N88-11313#** Negev Univ., Beersheva (Israel). Nuclear Research Center.

**SHORT RANGE FORECAST OF THE DAILY MAXIMUM TEMPERATURE**

D. Skibin, H. Ohaion, A. Hod, and Z. Mahlev *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 441-443 (For primary document see N88-11239 02-47)

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A computerized system for short-range forecasting of the daily maximum temperature (Tmax) was developed and compared with the results of the manual forecast. The forecaster predicts Tmax at 10 am according to the present observations and the synoptic, meso, and microscale situation. The automatic system is based on the temperatures measured at 8 and 10 am, the wind direction and cloud cover at 10 am, and the climatological data of the average daily temperature variation. Results indicate a tendency of the forecaster to overestimate. About 50% of the forecasts are accurate within 1.25 C and 90% within 3 C. Only a few errors greater than 5 C are found. The automatic system is more accurate. In 60% of the cases the error is within 1.25 C. Only in one case does the error reach 4 C. ESA

**N88-11314#** National Meteorological Center, Washington, D.C. Development Div.

**REGIME DEPENDENT ANALYSIS EXPERIMENTS**

P. R. Julian and H. J. Thiebaux *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 445-450 (For primary document see N88-11239 02-47)

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Techniques for graphical depiction of the sea-level pressure (SLP) field covering regions in which the observed data may not be on the mesoscale, e.g., coastal areas with offshore interests, were studied. Optimum statistical objective analysis was refined using conditional or situation-dependent structure functions. The SLP analyses of an offshore region are based on observations from a network of stations in Maritime Canada and verified with buoy and drill-rig data. Modeling of the statistical structure depends on estimates of the gradient of the observed-minus-forecast pressure differences. The basis for this choice of conditioning is discussed, together with test results which show improvements compared with conventional analyses. ESA

**N88-11315#** Hamburg Univ. (West Germany). Inst. fuer Meteorologie.

**MESOSCALE SURFACE FIELD ANALYSIS FROM ROUTINE OBSERVATIONS**

H. Luthardt *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 451-456 (For primary document see N88-11239 02-47)

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A method which permits the analysis of mesoscale surface pressure and surface wind fields using only routine Global Telecommunication System data (on-line or from archives) is

presented. The procedure is based on a local multivariate analysis of pressure and wind near the surface. For regions with a sufficient density of observations, the results are found to be fairly independent on reasonable variations of the applied constraints. The procedure is applied to estimate surface wind and pressure fields for the North Sea area. Based on the analyzed fields, parameters describing the relationship between surface wind and pressure fields are improved, the influence of individual accelerations can be included, and the quality of routine observations at sea is checked. ESA

**N88-11316#** Kiel Univ. (West Germany). Inst. fuer Meereskunde.

**HIGH RESOLUTION DETERMINATION OF TRUE SURFACE WINDS AT SEA FROM WIND AND PRESSURE DATA**

L. Hasse and H.-A. Strunk *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 457-459 (For primary document see N88-11239 02-47)

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The wind field at the sea surface was derived by fitting a second order pressure surface to wind and pressure observations, with a boundary layer formulation. The results show that fitting wind and pressure observations together provides better spatial resolution than using either wind or pressure data alone. Wind data provide at least the same accuracy and less bias than pressure data, tested against independent wind observations. A stability and wind speed dependent boundary layer formulation results in less bias than a constant one. Fitting a second order polynomial in pressure is better than a linear fit. ESA

**N88-11317#** Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.

**OPPORTUNITIES FOR NOWCASTING AIR POLLUTION EPISODES AND ACCIDENTAL TOXIC AND RADIOACTIVE RELEASES** c45

R. A. Pielke, M. D. Moran, M. Segal, D. A. Wesley, and T. B. McKee *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 463-470 (For primary document see N88-11239 02-47)

(Contracts NA-81-RAH-00001; RP-1630-53; DAAL03-86-K-0175)

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A synoptic classification scheme, a mesoscale meteorological model, and a Lagrangian particle dispersion model for pollution transport and dispersion are reviewed. Such models can describe the transport and dispersion of pollutants released into time-varying, inhomogeneous atmospheric flows over complex terrain. Their requirements for initialization data and computer resources are greater than those for the simple models currently used, but these considerations are becoming less of an obstacle due to the greater availability and accessibility of meteorological observations and the much wider distribution of powerful and relatively inexpensive computers. ESA

**N88-11318#** Cape Town Univ. (South Africa). Dept. of Oceanography.

**REAL-TIME EVALUATION AND PREDICTION OF COASTAL DISPERSION NEAR THE SW TIP OF AFRICA**

Mark R. Jury *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 471-474 (For primary document see N88-11239 02-47)

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A system to monitor the local meteorology and predict the dispersion of effluents from a nuclear power station situated on the coast is presented. A computerized weather station forms the basis of the system and provides spatial definition of wind profiles and dispersion indices near the coastal interface by interpolation between a sensor array. To evaluate trends in dispersion conditions, an automatically updated display system enables the forecaster to view selected parameters over 24 hr (coastal) and 7 day (synoptic) cycles. For prediction of effluent trajectories, validated data are input to a real time three dimensional puff dispersion model. Model results are graphically presented under complex weather conditions to show how time and space changes are handled. ESA

**N88-11319#** Direction de la Meteorologie Nationale, Paris (France).

**EVALUATION OF A MESOSCALE PREDICTION SYSTEM WITH SURFACE WEATHER OBSERVATIONS AND COMPARISON WITH A LARGE-SCALE PREDICTION SYSTEM**

R. JuvanonduVachat, J. M. Audoin, M. Imbard, L. Musson-Genon, and J. P. Javelle *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 475-480 (For primary document see N88-11239 02-47)

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The Peridot fine mesh (35 km) system, to forecast screen level temperature and humidity, 10 m wind, cloudiness, and precipitations was evaluated using a statistical verification where the predicted parameters are compared with surface weather observations. The error statistics for a year are presented in terms of the range of the prediction. The verification package was also applied to the large-scale EMERAUDE forecasting system, whose output was interpolated to fine scale Peridot grid. The comparison of both scores gives an objective evaluation of the positive impact of the mesoscale forecast against the large scale one, concerning the low level parameters. ESA

**N88-11320#** Norwegian Meteorological Inst., Blindern.

**THE NORWEGIAN MESOSCALE NUMERICAL WEATHER PREDICTION (NWP) SYSTEM**

Sigbjoern Groenaas, Anstein Foss, and Knut Helge Midtboe *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 481-486 (For primary document see N88-11239 02-47)

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A mesoscale numerical weather forecasting system based on a grid point sigma coordinate primitive equation model was evaluated. The model is found to be valuable for polar low prediction. Precipitation prediction is satisfactory. Very short range prediction is useful in daily weather monitoring. ESA

**N88-11321#** Norwegian Meteorological Inst., Blindern.

**FORECASTING POLAR LOWS USING A NUMERICAL MESOSCALE MODEL**

Knut Helge Midtboe and Magne Lystad *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 487-490 (For primary document see N88-11239 02-47)

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A numerical weather prediction system with horizontal resolution of 50 km was used to simulate polar low cases, and in daily operational prediction. The initial development of polar lows is in most cases predicted correctly by the model even without any indications in the initial analyses. Nearly all developments are connected to shallow baroclinic zones which depend on the distribution of land, sea ice, and sea surface temperature. The observed rapid intensification of polar lows is less well predicted by the model. ESA

**N88-11322#** Naval Environmental Prediction Research Facility, Monterey, Calif.

**DEVELOPMENT AND TESTING OF A VERTICALLY-NESTED REGIONAL PREDICTION SYSTEM**

Stephen D. Burk and William T. Thompson *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 491-496 (For primary document see N88-11239 02-47)

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A technique in which a high-resolution grid is vertically nested within the existing coarser resolution grid of a regional numerical weather prediction model was developed. Time-dependent boundary layer equations with full physics parameterization are solved on the fine grid, while dynamics are computed on the

coarse mesh. The two grids interact fully each time step. Model results for cases run in the North Atlantic with a 31x31 horizontal domain having 80 km spacing between gridpoints are presented. The coarse grid contains 10 layers with the top near 50 mb, while the fine grid has 20 layers, the bulk of which are concentrated in the lowest 300 mb. ESA

**N88-11323#** Science Applications International Corp., McLean, Va.
**PRELIMINARY RESULTS FROM REAL DATA EXPERIMENTS WITH THE NRL MESOSCALE NUMERICAL MODEL**
Keith D. Sashegyi, Simon W. Chang, and Rangaro V. Madala (Naval Research Lab., Washington, D.C.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 497-500 Sponsored by SPAWAR and NRL (For primary document see N88-11239 02-47)
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The limited area weather prediction model split-explicit scheme to integrate in time is shown to greatly reduce the amplitude of the unwanted external gravity wave oscillations in the first 3 to 4 hr of integration. A static nonlinear initialization procedure provides a balanced initial state, except for an initial adjustment of the vertical motion in the first 5 hr of integration. Examples of model forecasts for the cases of an explosive cyclogenesis and for a cold-air damming and coastal front event are shown. ESA

**N88-11324*#** R-Scan Corp., Minneapolis, Minn.
**SHORT RANGE FORECASTING OF SEA BREEZE GENERATED THUNDERSTORMS AT THE KENNEDY SPACE CENTER: A REAL-TIME EXPERIMENT USING A PRIMITIVE EQUATION MESOSCALE NUMERICAL MODEL**
Walter A. Lyons, Jerome A. Schuh, Dennis Moon, Roger A. Pielke, William Cotton, and Raymond Arritt (ASTeR, Inc., Fort Collins, Colo.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 503-508 (For primary document see N88-11239 02-47)
(Contracts NAS10-11142; NAS10-11321)
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The operational efficiency of using guidance from a mesoscale numerical model to improve sea breeze thunderstorm forecasts at and around the Shuttle landing strip was assessed. The Prognostic Three-Dimensional Mesoscale (P3DM) model, developed as a sea breeze model, reveals a strong correlation between regions of mesoscale convergence and the triggering of sea breeze convection thunderstorms. The P3DM was modified to generate stability parameters familiar to the operational forecaster. In addition to the mesoscale fields of wind, vertical motion, moisture, temperature, a stability indicator, a combination of model-predicted K and Lifted Indices and the maximum grid cell vertical motion, were proposed and tested. Results of blind tests indicate that a forecaster, provided with guidance derived from model output, could improve local thunderstorm forecasts. ESA

**N88-11325#** British Columbia Univ., Vancouver. Dept. of Geography.
**VALIDATION OF A THREE DIMENSIONAL NUMERICAL MODEL OF THE SEA BREEZE IN COMPLEX TERRAIN**
D. G. Steyn and I. G. McKendry *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 509-515 (For primary document see N88-11239 02-47)
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The performance of the Colorado State University three dimensional numerical mesoscale model was validated by comparing the model output variables with observed values of wind fields, temperature fields, surface energy fluxes, and wind profiles during a 24 hr period. While the model results are generally in good agreement with observed data, the model appears unable to cope with steeper terrain in parts of the domain. ESA

**N88-11326#** Academia Sinica, Beijing (China). Inst. of Atmospheric Physics.
**THE MESOSCALE NUMERICAL MODEL FOR HEAVY RAINFALL FORECASTING IN YANGTZE RIVER VALLEY, CHINA**
Xiaoping Zhou, Kesu Zhang, Sixiong Zhao, and Suhong Liu *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 517-519 (For primary document see N88-11239 02-47)
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A mesoscale numerical model combining a hydrostatic model with a one-dimensional time-dependent cloud model was developed to predict mesoscale heavy rainfall over China in the summer monsoon season. The model has a specially developed objective analysis for the initial data in order to conserve more information of strong convergence needed for heavy rainfall formation. A method to make the model computationally stable for such large wind convergence was designed. In 1983-1986, 26 cases of heavy rainfall in the middle reach of the Yangtze River were predicted successfully. The technical score for heavy rain greater than 50 mm/day is 25.4 and for greater than 25 mm/day is 38.1. The statistics of 54 heavy rain centers show that the average position deviation of the predicted centers from the observed ones is 90 km, and the average precipitation amount difference between the predicted and observed is 15.5%. ESA

**N88-11327#** Air Force Geophysics Lab., Hanscom AFB, Mass.
**THE IMPACT ON SHORT-TERM PRECIPITATION FORECAST SKILL OF TIME-DEPENDENT LATERAL AND LOWER BOUNDARY CONDITIONS WITHIN A MESO-BETA NUMERICAL CLOUD PREDICTION MODEL**
G. Modica *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 521-525 (For primary document see N88-11239 02-47)
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A meso-beta predictive grid point model with a detailed microphysics parameterization of gridscale (20km) warm-cloud processes is described. The model is initialized with a mesoscale data set; 6 hr model-predicted rainfall amounts are compared with observed amounts and predictions from subsequent model runs which include a surface energy budget, and a time dependent lateral boundary condition. Results indicate that the time dependent boundary condition has a much more marked effect on the evolution and the total accumulation of precipitation. ESA

**N88-11328#** Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
**MESOSCALE ANALYSIS AND NOWCASTING VIA A NUMERICAL MODEL COUPLED WITH SATELLITE SOUNDER DATA**
Alan E. Lipton and Thomas H. VonderHaar *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 527-532 Sponsored by NSF (For primary document see N88-11239 02-47)
(Contract NA-84-AAH-00020)
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A method for multidimensional analysis and nowcasting that combines remotely sensed data on water vapor and ground surface temperature with mesoscale numerical modeling is presented. Mesoscale organization of convective clouds where terrain characteristics provide the primary forcing of circulations is emphasized. Idealized experiments show that a coupled analysis of water vapor is more accurate than analyses performed by simpler, more traditional methods. Surface heat fluxes can be guided more accurately by surface temperature retrievals than by relying solely on computation of surface energy budgets. A case study from the high plains of the U.S. demonstrates strengths and weaknesses of performing analyses and nowcasts based on these methods. ESA

**N88-11329#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**A REAL-DATA NUMERICAL STUDY AND FOUR-DIMENSIONAL DATA ASSIMILATION APPLICATION FOR MESOBETA-SCALE FLOW IN COMPLEX TERRAIN**
David R. Stauffer and Nelson L. Seaman *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 533-538 (For primary document see N88-11239 02-47)
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A mesoscale three-dimensional numerical model, using realistic terrain and initialized with real data, is used to investigate mechanisms for observed valley flow in two cases for a specific mountain-valley system. In one case where the regional scale flow was normal or opposite in direction to the observed flow within the valley, model results indicate that channeling, thermally-induced slope winds, and turbulent mixing effects contribute to the observed valley flow. A separate 6 hr simulation using four-dimensional assimilation of the observations through the period for each case shows that this technique can be used to reduce model forecast errors on the mesobeta-scale. ESA

**N88-11330#** Atmospheric Environment Service, Downsview (Ontario).
**A PRELIMINARY DEMONSTRATION OF THE USE OF BOUNDARY-LAYER MODELS OF FLOW IN COMPLEX TERRAIN FOR HIGH RESOLUTION SURFACE WIND FORECASTING**
J. L. Walmsley and P. A. Taylor *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 539-543 (For primary document see N88-11239 02-47)
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Models of surface boundary-layer flow in complex terrain were developed for wind energy and wind engineering applications. They predict the spatial variations in winds caused by topography and surface roughness variations on horizontal scales of 0.1 to 10 km. The models are steady state and are primarily applied in high wind situations with neutral thermal stability. Application to high resolution, surface wind forecasting, or subgrid scale interpolation, is described. ESA

**N88-11331#** Swedish Meteorological and Hydrological Inst., Norkoeping.
**OPPORTUNITIES AND PROBLEMS IN MESOSCALE OBJECTIVE ANALYSIS**
Nils Gustafsson *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 545-554 (For primary document see N88-11239 02-47)
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Mesoscale objective analysis for nowcasting and very short-range forecasting is reviewed. Results from a high resolution data assimilation experiment are discussed. The advantages of data assimilation with high resolution models and the need for more physically and dynamically based objective analysis schemes are emphasized. ESA

**N88-11332#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.
**AN ISENTROPIC MESOSCALE ANALYSIS SYSTEM**
Stanley G. Benjamin *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 555-560 (For primary document see N88-11239 02-47)
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An objective analysis scheme for meteorological variables on constant potential temperature surfaces is presented. The analysis and an isotropic forecast model are parts of a mesoscale data assimilation scheme with a planned update cycle of 3 hr. The scheme uses statistical interpolation and is designed to retain mesoscale detail in observations including rawinsonde, surface, aircraft, satellite, and wind and thermodynamic profiler data, while combining them with a forecast background (first guess) field. Comparisons of isentropic and constant pressure analyses are shown, and examples of the effects of different data types on isentropic analyses are presented. ESA

**N88-11333#** National Oceanic and Atmospheric Administration, Boulder, Colo. Environmental Research Labs.
**AN ISENTROPIC COORDINATE MODEL USED IN A MESOSCALE DATA ASSIMILATION SYSTEM**
Renate Brummer *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 561-564 (For primary document see N88-11239 02-47)
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A multilayer isentropic coordinate model was used to create 12 hr real time numerical weather forecasts as part of a meso-alpha-scale data assimilation system. The primitive equation model is based on the assumption of dry-adiabatic and hydrostatically balanced atmospheric flow. Time dependent lateral boundary conditions are taken from an external forecast model. The initial conditions for the model are provided by an isotropic analysis scheme. ESA

**N88-11334#** Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
**AN IMPROVED METHOD OF ANALYZING SURFACE GEOSTROPHIC WINDS AND PRESSURE**
Roger A. Pielke and Jennifer M. Cram *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 565-567 (For primary document see N88-11239 02-47)
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A method to analyze surface geostrophic wind in terrain-following coordinates and then derive the corresponding geostrophic pressure analysis is introduced. Surface geostrophic wind is analyzed in terrain-following coordinates, i.e., the sum of a surface pressure gradient term and a surface elevation gradient term. The geostrophic pressure analysis corresponding to this wind analysis is then derived. The resulting geostrophic surface wind and pressure analyses are much more realistic than those derived with a standard atmosphere reduction, and as a result are more useful in the interpretation of surface pressure gradients and winds in areas of complex terrain. Pressure and wind analyses derived with the method is compared to those derived with a standard atmosphere reduction. ESA

**N88-11335#** Meteorological Office, Bracknell (England).
**STRATEGIES FOR USING MESOSCALE DATA IN AN OPERATIONAL MESOSCALE MODEL**
B. W. Golding *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 569-578 (For primary document see N88-11239 02-47)
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The options for initialization of mesoscale numerical weather forecasting models were investigated. It is shown that the observational coverage is grossly inadequate and likely to remain so but that considerable information on the types of structures present can be deduced from satellite and radar imagery. A framework for the development of initialization techniques in which imagery is used to classify the structures present, and models of these structures are calibrated using the quantitative information available from observing system is suggested. Case studies demonstrate the importance of the moisture field in determining short term evolution. In one case the timing of a frontal rain band was improved in the first 6 hr by moving the region of saturation consistently with satellite imagery and the precipitation distribution. ESA

**N88-11336#** Wisconsin Univ., Madison. Cooperative Inst. for Meteorological Satellite Studies.
**METHODS OF INCORPORATING SATELLITE DATA INTO MESOSCALE NUMERICAL FORECAST MODELS**

George R. Diak and Graham A. Mills (Bureau of Meteorology, Melbourne, Australia ) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 579-588 (For primary document see N88-11239 02-47)
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The role of satellite soundings and cloud and water vapor drift winds in mesoscale meteorology is reviewed. The data and their characteristics, and the numerical techniques used for their assimilation into numerical forecast models are surveyed. ESA

**N88-11337#** National Weather Service, Washington, D.C.
**TOWARD OPTIMIZING THE USE OF DATA FOR OPERATIONAL MESOSCALE FORECASTING AT THE NATIONAL METEOROLOGICAL CENTER**
William G. Collins, James Tuccillo, J., and David F. Parrish *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 589-593 (For primary document see N88-11239 02-47)
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The impact of data from wind profilers, giving winds accurate to 1 to 2 m/sec to 16 km height or more at 1 hr interval, and of operational forecast models able to predict at the middle of the mesoscale, on operational methods of analysis, data assimilation, and model initialization is considered. An approach to more adequately incorporate all sources of data, including significant level data and surface data, and to allow the information content of this data to influence the initial state from which a forecast is made is outlined. ESA

**N88-11338#** Bureau of Meteorology, Melbourne (Australia).
**ASSIMILATION OF HIGH RESOLUTION TOVS DATA INTO A MESOSCALE NWP MODEL**
G. A. Mills and J. F. LeMarshall *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 595-598 (For primary document see N88-11239 02-47)
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Locally received TOVS atmospheric sounder data were processed using the one-step physical retrieval scheme. The data are analyzed using an incremental statistical interpolation limited area data assimilation system. Results with analyses performed at 6-hr intervals and with a grid spacing of 100 km show encouraging analysis and short term prognosis impact using these data. ESA

**N88-11339*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**A VAS-NUMERICAL MODEL IMPACT STUDY USING THE GAL-CHEN VARIATIONAL APPROACH**
Robert M. Aune, Louis W. Uccellini, Ralph A. Peterson, and James J. Tuccillo (National Meteorological Center, Washington, D.C.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 599-604 (For primary document see N88-11239 02-47)
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Numerical experiments to assess the impact of incorporating temperature data from the VISSR Atmospheric Sounder (VAS) using the assimilation technique developed by Gal-Chen (1986) modified for use in the Mesoscale Atmospheric Simulation System (MASS) model were conducted. The scheme is designed to utilize the high temporal and horizontal resolution of satellite retrievals while maintaining the fine vertical structure generated by the model. This is accomplished by adjusting the model lapse rates to reflect thicknesses retrieved from VAS and applying a three-dimensional variational that preserves the distribution of the geopotential fields in the model. A nudging technique whereby the model temperature fields are gradually adjusted toward the updated temperature fields during model integration is also tested. An adiabatic version of MASS is used in all experiments to better isolate mass-momentum imbalances. The method has a sustained impact over an 18 hr model simulation. ESA

**N88-11340#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**USE OF FOUR-DIMENSIONAL DATA ASSIMILATION TO IMPROVE A MESOSCALE-MODEL PRECIPITATION FORECAST: A CASE STUDY**
Wei Wang and Thomas T. Warner *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 605-610 (For primary document see N88-11239 02-47)
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Experiments using radar data supplemented with precipitation gage data, applicable at the initial time of the forecast, to specify the latent heating term in the atmospheric thermodynamic equation during the first 1 to 2 hr after a static initialization are described. Dynamic initialization by Newtonian forcing was used during a 12 hr preforecast period to develop initial conditions with reasonable mesoscale structure. In both cases, the Penn State/National Center for Atmospheric Research mesoscale model is employed. Both procedures improve the quality of a mesoscale convective precipitation forecasts. ESA

**N88-11341#** Japan Meteorological Agency, Tokyo. Numerical Prediction Div.
**MESOSCALE VERY SHORT-RANGE NUMERICAL PREDICTION WITH DYNAMICAL INITIALIZATION INCLUDING CONDENSATION HEATING**
K. Ninomiya, R. Taira, M. Ueno, K. Kurihara, and T. Kudo *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 611-616 (For primary document see N88-11239 02-47)
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The condensation heating rate is estimated from dense raingage, radar, and satellite observation data. The time integration of the model is made with the prescribed forced heating for the early period of the integration. The results of experiments for two cases of intense rainfall show the remarkable improvement in the accuracy of the mesoscale very short range numerical prediction. ESA

**N88-11342#** Atmospheric Environment Service, Dorval (Quebec). Recherche en Prevision Numerique.
**IMPACT OF A DIRECT ASSIMILATION OF SATELLITE-INFERRED PRECIPITATION RATES INTO A REGIONAL METEROLOGICAL MODEL**
R. Benoit and M. Roch *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 617-623 (For primary document see N88-11239 02-47)
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A method for the injection of satellite-derived rainfall rates data (RAINSAT system) into the initialization procedure of a high-resolution forecast model was designed. The GOES resolution (8 km) instantaneous rainrate valid for t less than or = 0 is converted into a vertical distribution of heating rates and averaged to model resolution. The initial moisture field is also adjusted in a two-step manner to recognize the top view of the cloudy regions and the saturation condition of the condensing layers. The injection scheme is demonstrated with a summer stratiform precipitation case deepening by 7 mbar during the first 12 hr of forecast. ESA

**N88-11343#** Oklahoma Univ., Norman. School of Meteorology.
**INITIALIZATION EXPERIMENTS WITH THE NMC NESTED GRID MODEL**
Frederick H. Carr, Richard L. Wobus, and Ralph A. Petersen (National Meteorological Center, Washington, D.C.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 625-630 (For primary document see N88-11239 02-47)
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Modifications to the original analysis fields due to the nonlinear normal mode initialization (NNMI) step, which uses National Meteorological Center global spectral model adiabatic, hemispheric

normal modes, with the results interpolated to nested grid model (NGM) grids were assessed. Comparison between the analyzed and initialized fields shows that the NNMI removes most of the divergent circulations associated with organized convective systems and leads to a systematic spin-up problem during the first 6 to 12 hr of the forecast. Forecasts without NNMI have better precipitation totals but an unacceptable level of external gravity wave activity. A sequence of initialization experiments are performed to determine the best alternative procedure to the current scheme. The procedures are evaluated by repeating NGM forecasts for periods of heavy precipitation over the U.S. ESA

**N88-11344#** Oklahoma Univ., Norman. School of Meteorology.
**THE FUTURE OF DATA IN MESOSCALE NUMERICAL MODELS**
Tzvi Gal-Chen *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 637-639 (For primary document see N88-11239 02-47)
(Grants NA-85-RAH-05046; NSF ATM-85-13364)
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It is argued that remotely sensed meteorological data particularly from Doppler radars and satellites can produce an order of magnitude increase in temporal and horizontal resolution over what is available from the conventional synoptic network. The challenge is to produce initial conditions which are compatible with the models and observations. ESA

**N88-11345#** Universities Space Research Association, Huntsville, Ala.
**SIMULATION OF MESOSCALE SATELLITE SOUNDER DATA FROM A MESOSCALE NUMERICAL MODEL**
Michael W. Kalb *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 641-644 (For primary document see N88-11239 02-47)
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Techniques by which radiative transfer codes can be linked to mesoscale model output in order to simulate what a given satellite passive sounder would see meteorologically, if observing the evolving model atmosphere are discussed. The idea is to anticipate the ability of current and future satellite sounders to depict mesoscale atmospheric structures. Methods for evaluation of satellite sounding data in terms of radiance patterns, derived thermodynamic fields, and in terms its ability to enhance mesoscale numerical weather prediction are discussed. ESA

**N88-11346#** Bureau of Meteorology, Melbourne (Australia).
**THE CHALLENGE OF USING MESOSCALE DATA IN MESOSCALE NUMERICAL MODELS**
G. A. Mills *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 645-648 (For primary document see N88-11239 02-47)
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Challenges faced in incorporating mesoscale data into mesoscale numerical models are discussed in the context of the design and development of an operational limited area data assimilation system. Problems when such a system is extended to higher resolution in time and space, and in the use of newer data types are considered. ESA

**N88-11347#** National Oceanic and Atmospheric Administration, Boulder, Colo. Program for Regional Observing and Forecasting Services.
**THE CHALLENGE OF USING MESOSCALE DATA IN MESOSCALE NUMERICAL MODELS: A POSITION PAPER**
Thomas W. Schlatter *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 653-657 (For primary document see N88-11239 02-47)
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Using the great variety of mesoscale data becoming available in the United States is discussed. The challenge of exploiting these data lies in assimilating them into models because the methods of measurement and error characteristics vary so widely. Effective quality control is more essential than ever and must take advantage of redundancies in the data. Background fields should be calculated for the variables observed, and the residuals assimilated directly, even if they are in the form of radiances. The computationally expensive adjoint method fits model to data at different times, thus avoiding initialization, but is tested only on simple systems. Improved mesoscale models rely heavily on specification of the lower boundary. ESA

**N88-11348*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**COMMENTS ON THE CHALLENGE OF USING MESOSCALE DATA IN MESOSCALE NUMERICAL MODELS**
Louis W. Uccellini *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 659-661 (For primary document see N88-11239 02-47)
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The dangers of addressing the initialization issues for limited-area mesoscale models by extending the lessons learned during the development of global analysis and prediction systems are discussed. Lack of impact with data inserts at one time suggests that the lateral boundary conditions imposed on the limited-area models might force the model simulation toward a preferred solution, work against the new data being inserted into the model and, therefore, limit the potential impact that this data can have on the model system. The second potential pitfall involves the imposition of balance constraints on the data that are being inserted into the model to compute winds from temperature data and/or temperature from wind data. ESA

**N88-11349#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**FOUR-DIMENSIONAL INITIALIZATION OF MESOSCALE MODELS**
Thomas T. Warner *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 663-665 (For primary document see N88-11239 02-47)
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The use of four-dimensional data assimilation procedures in mesoscale models is reviewed. Four-dimensional initialization of models on all scales has great promise and is the only way of capitalizing on the many new types of data that are becoming available. However, low spatial density of data and the resulting necessity of separating the model-simulated scales and the model-assimilated scales is a challenging problem. Development of procedures for incorporating observed, time-dependent forcing as well as special fields from radar and satellite measurement systems require considerable creativity. ESA

**N88-11350#** Sail America Foundation, San Diego, Calif.
**MESOSCALE ANALYSIS AND FORECASTING FOR THE 1987 AMERICA'S CUP, FREMANTLE, WESTERN AUSTRALIA**
Christopher D. Bedford and R. Leland Davis (Galson Technical Services, Syracuse, N.Y.) *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 669-675 (For primary document see N88-11239 02-47)
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The operational mesoscale forecasting program used by a racing yacht is described. Two models were used to produce daily weather forecasts. An analog-type model which related key synoptic features to each sea breeze event was developed. A primitive equation numerical sea breeze model was employed in two and three dimensional mode to improve resolution and provide guidance during near static synoptic conditions. Inputs to the model were obtained from a mesoscale monitoring network located in the vicinity of the race course, a sodar located on the coastline, and soundings taken from an airport. ESA

**N88-11351#** Atmospheric Sciences Lab., White Sands Missile Range, N. Mex.
**WINDFIELD SIMULATIONS FROM A HIERARCHY OF NESTED MESO- AND MICROMETEOROLOGICAL MODELS**
Ronald M. Cionco *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 677-683 (For primary document see N88-11239 02-47)
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Numerical simulations of Project WIND meteorological scenarios were analyzed by a heirarchy of models on the meso and microscales over variable terrain. The observations were collected on the meso and microscales simultaneously as the set of evaluation data. The comparisons of the observations to the model simulations give very good results. The hierarchy of models produces coherent and reasonable fields in magnitude and direction and compares well with the observations. Examples of simulations versus observations are presented for 1500, 0100, and 0900 hours during a 24 hr simulation. ESA

**N88-11352#** National Meteorological Center, Washington, D.C. Development Div.
**THE EFFECT OF ENHANCED CONVENTIONAL AND VAS MOISTURE ANALYSIS ON RAFS SHORT-RANGE PRECIPITATION FORECASTS**
Ralph A. Petersen and Diedre M. Kann *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 687-692 (For primary document see N88-11239 02-47)
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Experiments to evaluate the accuracy of the operational National Meteorological Center regional analysis and forecasting system low-level moisture analyses in anticipation of a test of the inclusion of satellite moisture data are described. Experiments were made to increase the resolution of the regional optimum interpolation in which the grid spacing was reduced, the first guess was augmented, and the influence of surface observations was increased. While the specific humidity analyses in the lowest sigma level show increased mesoscale detail and reflect the strong surface frontal gradients better in these experiments, the derived relative humidity fields are persistently underestimated in areas of substantial surface heating. This problem was traced to difficulties in the vertical treatment of the lowest level height corrections in the analyses, which produce anomalous warming above the boundary layer. ESA

**N88-11353#** National Oceanic and Atmospheric Administraion, Fort Collins, Colo. Satellite Applications Lab.
**MESOSCALE FORECASTING WITH SATELLITE DATA: CHALLANGES AND OPPORTUNITIES FOR TODAY AND TOMORROW**
James F. W. Purdom *In* ESA, Mesoscale Analysis and Forecasting Aug. 1987 p 693-696 (For primary document see N88-11239 02-47)
(Grants NA-85-RAH-05045; NA-84-AAH-00020; NA-84-AAD-00017)
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The use of satellite imagery to study the effect of early cloud cover on afternoon thunderstorm development and arc cloud lines and convective scale interaction is discussed. Future meteolorological satellites are described. ESA

**N88-11354#** National Oceanic and Atmospheric Administration, Seattle, Wash. Marine Environmental Lab.
**COASTAL WINDS OF THE SOUTHEAST ALASKA PENINSULA**
S. A. Macklin May 1987 137 p
(PB87-206173; NOAA-TM-ERL-PMEL-73; CONTRIB-823) Avail: NTIS HC A07/MF A01 CSCL 04B

Hourly measurements of wind speed and wind direction from Cerni Island, Thin Point, Cold Bay, and Ugaiushak Island during the latter half of 1984 and the first half of 1985 show evidence of orographic steering of winds in the coastal zone. Surface wind directions at Cerni Island, Thin Point, and Cold Bay often were attributable - 30% of the time at Cherni Island and Thin Point, 50% of the time at Cold Bay - to channelling of the wind by a gap in the Aleutian Range. GRA

**N88-11355#** Pacific Northwest Labs., Richland, Wash.
**HANFORD METEOROLOGICAL STATION COMPUTER CODES. VOLUME 2: THE PROD COMPUTER CODE**
G. L. Andrews and J. W. Buck Sep. 1987 33 p
(Contract DE-AC06-76RL-01830)
(DE87-014807; PNL-6279-Vol-2) Avail: NTIS HC A03/MF A01

At the end of each work shift (day, swing, and graveyard), the Hanford Meteorological Station (HMS), operated by Pacific Northwest Laboratory, issues a forecast of the 200-ft-level wind speed and direction and the weather for use at B Plant and PUREX. These forecasts are called production forecasts. The PROD computer code is used to archive these production forecasts and apply quality assurance checks to the forecasts. The code accesses an input file, which contains the previous forecast's date and shift number, and an output file, which contains the production forecasts for the current month. A data entry form consisting of 20 fields is included in the program. The fields must be filled in by the user. The information entered is appended to the current production monthly forecast file, which provides an archive for the production forecasts. This volume describes the implementation and operation of the PROD computer code at the HMS. DOE

**N88-11356#** Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
**SUMMARY OF 1987 ATLANTIC TROPICAL CYCLONE ACTIVITY AND VERIFICATION OF AUTHOR'S SEASONAL FORECAST**
William M. Gray 24 Nov. 1987 23 p
Avail: NTIS HC A03/MF A01

Tropical cyclone activity which occurred in the Atlantic in 1987 is summarized and the author's seasonal forecast of this activity that was issued in late May and updated in late July is verified. This forecast was based on previous research which relates seasonal Atlantic hurricane activity to: (1) the El Nino; (2) the Quasi-Biennial Oscillation of equatorial 50 mb stratospheric wind; (3) the Caribbean Basin-Gulf of Mexico Sea Level Pressure Anomaly in spring and early summer; and (4) lower latitude Caribbean Basin 200 mb zonal wind anomaly in June and July. Information received indicated that the 1987 hurricane season should have been a slightly below average year with about 5 hurricanes. Updated information reinforced this prediction. The actual number of hurricanes which occurred in 1987 was 3. In terms of the overall intensity of tropical cyclones, the 1987 season was even more suppressed than was indicated. The global environmental factors of the El Nino and the Stratospheric QBO winds were both unfavorable for intense hurricane activity this season. The odds are high that next season should be significantly more active than this season. Author

**N88-11357*#** Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
**CONVECTIVE SCALE INTERACTION: ARC CLOUD LINES AND THE DEVELOPMENT AND EVOLUTION OF DEEP CONVECTION**
James Francis Whiteh Purdom 1986 215 p
(Contract NAS8-36472; Grants NAGw-504; NAG5-359)
(NASA-CR-181469; NAS 1.26:181469) Avail: NTIS HC A10/MF A01 CSCL 04B

Information is used from satellite data and research aircraft data to provide new insights concerning the mesoscale development and evolution of deep convection in an atmosphere typified by weak synoptic-scale forcing. The importance of convective scale interaction in the development and evolution of deep convection is examined. This interaction is shown to manifest itself as the merger and intersection of thunderstorm outflow boundaries (arc cloud lines) with other convective lines, areas or boundaries. Using geostationary satellite visible and infrared data convective scale interaction is shown to be responsible for over 85 percent of the intense convection over the southeast U.S. by

late afternoon, and a majority of that area's afternoon rainfall. The aircraft observations provided valuable information concerning critically important regions of the arc cloud line: (1) the cool outflow region, (2) the density surge line interface region; and (3) the sub-cloud region above the surge line. The observations when analyzed with rapid scan satellite data, helped in defining the arc cloud line's life cycle as 3 evolving stages. Author

**N88-11358#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Abteilung fuer Meteorologische Modelle.
**DOCUMENTATION OF THE REGIONAL CLIMATE MODEL BASED ON FITNAH**
Gerd Frenzen, Dietrich Heimann, and Michael Warnser Apr. 1987 95 p In GERMAN; ENGLISH summary
(Contract BMFT-KF-3012-4)
(DFVLR-MITT-87-07; ISSN-0176-7739; ETN-87-90777) Avail: NTIS HC A05/MF A01; DFVLR, Cologne, West Germany DM 31.52

The three-dimensional nonhydrostatic model FITNAH was modified to serve as a working model for studies during a climate research program. The documentation presented compiles the model and describes the computer code and the user interfaces. It also includes test cases. ESA

**N88-11359#** Bradford Univ. (England). Postgraduate School of Electrical and Electronic Engineering.
**DEVELOPMENT OF A CLIMATIC MAP OF RAINFALL ATTENUATION FOR EUROPE Final Report**
P. A. Watson, J. Leitao, O. Turney, and N. Sengupta Paris, France ESA Jan. 1985 119 p
(Contract ESTEC-5192/82-NL-GM)
(Rept-372; ESA-CR(P)-2431; ETN-87-90887) Avail: NTIS HC A06/MF A01

A method for attenuation prediction which, when tested using a significant data base, performs better than all other techniques and gives an rms error of 20 percent was developed. The method was derived independently from radar based meteorological measurements plus scattering theory. No attempt was made to adjust the model to giver zero mean error for the COST data base. ESA

**N88-11360#** National Weather Service, Garden City, N.Y.
**SEVERE WEATHER POTENTIAL (SPOT) PLOTFILE GENERATOR**
K. LaPenta Jul. 1987 35 p
(PB87-217717; NOAA-NWS-ERCP-41) Avail: NTIS HC A03/MF A01 CSCL 04B

Miller and Maddox (Maddox, 1973) developed a severe storm potential index (SPOT) computed from surface observations. Shulhan (1978) developed a technique for using the SPOT index to define areas of potential severe weather. Manually computing the indices required for a regional analysis is very time consuming. The AFOS applications program calculates the index values and generates a plotfile so a regional map can be created quickly. GRA

**N88-11361#** National Weather Service, Salt Lake City, Utah.
**CONVECTIVE CROSS SECTION ANALYSIS**
T. W. Barker Jun. 1987 43 p
(PB87-204566; NOAA-NWS-WRCP-55) Avail: NTIS HC A03/MF A01 CSCL 04B

The programs described in the document generate cross sections of a variety of fields to help identify areas of potential instability, symmetric instability, and the evolution of potentially unstable layers with time. The identification and location of such instabilities can be very helpful in identifying areas likely for convection during short term forecasts. The main purpose of the document is to fully describe the programs which produce these cross section graphics. These programs were developed to calculate the necessary values of equivalent potential temperature, dew-point depression and momentum, and graphically display these variables in a cross section format. These programs all create a standardized gridded data file which is transformed into a cross section graphic by a final contouring program. GRA

# 48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

**N88-11362*#** Ohio State Univ., Cleveland. Dept. of Geodetic Science and Surveying.
**SPHERICAL HARMONIC EXPANSION OF THE LEVITUS SEA SURFACE TOPOGRAPHY**
Theodossios Engelis Oct. 1987 49 p
(Grant NAG5-781)
(NASA-CR-181448; NAS 1.26:181448; Rept-385) Avail: NTIS HC A03/MF A01 CSCL 08C

Prior information for the stationary sea surface topography (SST) may be needed in altimetric solutions that intend to simultaneously improve the gravity field and determine the SST. For this purpose the oceanographically derived SST estimates are represented by a spherical harmonic expansion. The spherical harmonic coefficients are computed from a least squares adjustment of the data covering the majority of the oceanic regions of the world. Several tests are made to determine the optimum maximum degree of solution and the best configuration of the geometry of the data in order to obtain a solution that fits the data and also provides a good spectral representation of the SST. Author

**N88-11363#** Colorado Univ., Boulder. Cooperative Inst. for Research in Environmental Sciences.
**ON THE SURGING POTENTIAL OF POLAR ICE STREAMS. ANTARCTIC SURGES: A CLEAR AND PRESENT DANGER**
U. Radok, D. Jenssen, and B. McInnes Jul. 1987 69 p Prepared in cooperation with Melbourne Univ., Parkville, Australia
(Contract DE-AC02-84ER-60197)
(DE87-013980; DOE/ER-60197/H1) Avail: NTIS HC A04/MF A01

Antarctic ice streams typically move hundreds of meters in a year. This investigation was carried out to determine whether polar ice streams can accelerate their motion from time to time by one or two orders of magnitude in the span of a few years, with appreciable effects on global sea level. The mass gains and losses of the Antarctic ice sheet as a whole closely balance one another. Three-dimensional steady-state fields of ice velocity and temperature in broad agreement with the as yet very scant observational record for the ice sheet. A numerical model which links the sliding motion of the ice to the energy dissipated by the friction between the ice and the underlying rock, was used to simulate the time-dependent behavior of eight ice streams representing the full range of Antarctic conditions. In contrast to the realistic alternation between fast advances and stagnating retreats which the model had produced for some mountain glaciers known to surge, the modeled ice streams instead went from steady to irregular continuous fast sliding when the prescribed ice deformability was reduced and/or the implied lubrication by frictional heating was increased. Substantial rapid advances did not develop, except as transient phases in two experiments. DOE

**N88-11364#** Office of Technology Assessment, Washington, D.C.
**MARINE MINERALS: EXPLORING OUR NEW OCEAN FRONTIER Summary Report**
Jul. 1987 44 p
(PB87-217725; OTA-O-343) Avail: NTIS HC A03/MF A01 CSCL 08A

The report on exploring the Exclusive Economic Zone (EEZ) for its mineral potential is in response to a joint request from the House Committee on Merchant Marine and Fisheries and the House Committee on Science, Space and Technology. It examines the

current knowledge about the hard mineral resources within the EEZ, explores the economic and security potential of seabed resources, assesses the technologies available to both explore for and mine those resources, identifies issues that face the Congress and the executive branch, and finally presents options to the Congress for dealing with these issues. GRA

# 51 LIFE SCIENCES (GENERAL)

**N88-11365#** Louisiana State Univ., Baton Rouge.
**A PHYSICO-CHEMICAL STUDY OF SOME AREAS OF FUNDAMENTAL SIGNIFICANCE TO BIOPHYSICS Annual Report, 1986-1987**
S. P. McGlynn 1 Jul. 1987 57 p
(Contract DE-FG05-87ER-60503)
(DE87-013457; DOE/ER-60503/295) Avail: NTIS HC A04/MF A01

The thirteen (13) titles (Nos. 283 to 295) of the Bibliography for the 1986 to 1987 Annual Report constitute the gist of this document. These titles represent work completed and published (or in process of publication). The scientific report which follows is intended to provide a brief summary of the ongoing research efforts of the Molecular Spectroscopy Group. The titles covered are as follows: Rare Gas Density Effects on High-M Rydberg States, Electric Field Dependence of the Total Excimer Luminescence of Xenon Excited Below the Atomic Ionization Limit, Term Value/Band-Gap Energy Correlations for Solid Rare Gas Excitons, Laser Optogalvanic Spectroscopy of Iodine and Cesium, Photoionization Spectroscopy of Highly Polar Aromatics, and Photochemistry of Polyatomic Molecules. There are six individual papers listed separately in this report. DOE

**N88-10848*#** Tennessee Technological Univ., Cookeville.
**RAPID TOXICITY DETECTION IN WATER QUALITY CONTROL UTILIZING AUTOMATED MULTISPECIES BIOMONITORING FOR PERMANENT SPACE STATIONS**
E. L. Morgan, R. C. Young, M. D. Smith (Tennessee Valley Authority, Knoxville.), and K. W. Eagleson *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 227-235 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 06B

# 52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N88-11366#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
**SLEEP AND WAKEFULNESS: HANDBOOK FOR FLIGHT MEDICAL OFFICERS, SECOND EDITION**
A. N. Nicholson and Barbara M. Stone (Royal Air Force Inst. of Aviation Medicine, Farnborough, England ) Jul. 1987 75 p
(AGARD-AG-270(E)) Copyright Avail: NTIS HC A04/MF A01

The first edition of this handbook was published in 1982, and since then the understanding of sleep and wakefulness has advanced considerably. This new handbook emphasizes the management of aircrew and the problems they experience in coping with irregularity of rest and activity. Author

**N88-11367*** National Aeronautics and Space Administration, Washington, D.C.
**AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES**
Nov. 1987 70 p
(NASA-SP-7011(303); NAS 1.21:7011(303)) Avail: NTIS HC A05 CSCL 06E

This bibliography lists 187 reports, articles, and other documents introduced into the NASA scientific and technical information system in October, 1987. Author

**N88-11368#** Institut National des Sciences Appliquees de Lyon, Villeurbanne (France).
**STUDY OF THE DISTRIBUTION OF A MULTI-ELECTRODE CIRCULAR SYSTEM SENSITIVITY FOR THE RECONTRUCTION OF BIOELECTRICAL IMPEDANCE IMAGES Ph.D. Thesis [ETUDE DE LA DISTRIBUTION DE LA SENSIBILITE D'UN SYSTEME CIRCULAIRE MULTI-ELECTRODES EN VUE DE LA RECONSTRUCTION D'IMAGES D'IMPEDANCE BIO-ELECTRIQUE]**
Georges Kardous 1987 156 p In FRENCH
(ISAL-IDI1-87-01; ETN-87-90898) Avail: NTIS HC A08/MF A01

The theoretical aspects of impedance technique imagery are reviewed and the experimental set-up for the in-vitro study of sensitivity distribution is described. The results are condensed in sensitivity records including the plane and volume sensitivity measurements in an eight electrode circular system. The analysis of applications includes the study of the inverse problem, that is the internal or cross section image reconstruction from a set of known injected currents and surface potential measurements. Examples of small matrix inversions are presented. ESA

# 53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N88-11369#** Association pour le Developpement de l'Enseignement et de la Recherche en Systematique Appliquee, Verrieres-le-Buisson (France).
**A RESEARCH ON PILOT PERFORMANCE IN THE CASE OF AIRCRAFT MALFUNCTION [UNE RECHERCHE SUR LE PILOTAGE EN SITUATION DE PANNE EN VOL]**
Didier Viard Mar. 1987 6 p In FRENCH
(Contract DRET-83-34-428-00-470-75-01)
(ETN-87-90652) Avail: NTIS HC A02/MF A01

Pilot reactions to malfunctions in 11 simulations carried out with a group of pilot trainees were studied. The studied variables included type of aircraft malfunction, individual experience, psychological factors, flight duration, and pilot workload. The role of workload, a large effect of personality factors, and a strong interaction with the type of malfunction are noted. ESA

**N88-11370#** Association pour le Developpement de l'Enseignement et de la Recherche en Systematique Appliquee, Verrieres-le-Buisson (France).
**A RESEARCH ON PILOT PERFORMANCE IN A FLIGHT INCIDENT SITUATION Final Report [UNE RECHERCHE SUR LE PILOTAGE EN SITUATION DE PANNE EN VOL]**
D. Viard and B. Gangloff Mar. 1987 188 p In FRENCH
(Contract DRET-83-34-428-00-470-75-01)
(ETN-87-90653) Avail: NTIS HC A09/MF A01

Pilot behavior during flight emergencies and incidents is studied to provide elements for the design of automated aircraft and pilot training and selection. The analysis includes experienced pilot interviews, flight incidents or accidents report analysis, observation of actual flight pilot performance, and flight simulator experiments in a pilot training institution. ESA

**N88-10879*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**A SYNOPSIS OF THE EVA TRAINING CONDUCTED ON EASE/ACCESS FOR STS-61-B**
Kathryn A. Havens *In* NASA. Langley Research Center, Hampton, Va. Space Construction Oct. 1987 p 153-182 (For primary document see N88-10870 02-18)
Avail: NTIS HC A14/MF A01 CSCL 05I

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

**N88-11371#** Dornier-Werke G.m.b.H., Friedrichshafen (West Germany). Space Development Div.
**ENVIRONMENTAL LIFE SUPPORT SYSTEM TECHNOLOGY STUDY Final Report**
Paris, France ESA Apr. 1987 34 p Prepared in cooperation with Brunel Univ., Uxbridge, United Kingdom, Constructiones Aeronauticsa S.A., Madrid, Spain and Kernforschungsanlage, Juelich, Federal Rep. of Germany
(Contract ESTEC-6052/84-NL-PB(SC))
(ESA-CR(P)-2432; ETN-87-90888) Avail: NTIS HC A03/MF A01

A spaceborne environmental life support system concept where alga (Chlorella sp.) is cultivated in a special culture vessel was developed. The oxygen-rich algae medium passes a gas exchanger where the oxygen is exchanged against carbon dioxide to supply the algae with a carbon source. Maltose should be extracted with a special membrane out of the medium, so that the medium can be recycled without problems. Oxygen and maltose are used to supply a maltose-consuming biological experiment (bacterial culture). ESA

**N88-10988#** Joint Publications Research Service, Arlington, Va.
**HUMAN FACTORS IN ROBOTIC SYSTEM DESIGN DISCUSSED**
V. N. Prokofyev and T. A. Chernysheva *In its* USSR Report: Engineering and Equipment 4 May 1987 p 53-56 Transl. into ENGLISH from Izvestiya Vysshykh Uchebnykh Zavedeniy: Mashinostroyeniye (Moscow, USSR), no. 8, Aug. 1986 p 76-78
(For primary document see N88-10985 02-31)
Copyright Avail: NTIS HC A07/MF A01

# 55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

# 59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

No abstracts in this category.

# 60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

**N88-11372#** Sandia National Labs., Albuquerque, N. Mex.
**AN EMBEDDED MULTIPROCESSOR COMPUTER FOR PROOF-OF-PRINCIPLE TESTING OF EXPLORATORY SYSTEMS CONCEPTS**
Charles R. Borgman and Larry J. Dalton 1987 11 p Presented at the 6th Conference on Computers in Aerospace, Wakefield, Mass., 7 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012735; SAND-87-0452C; CONF-8710105-1) Avail: NTIS HC A03/MF A01

Discussed is the SANDAC V multiprocessor embedded computer hardware and software. Its expandable design provides adequate computing power for testing of various proof-of-principle (POP) exploratory system concepts. It is built from state-of-the-art integrated circuits with ASIC glue chips. A powerful software development system, multiprocessor on-board debugger, and a multitasking operating system kernel provide a user friendly software environment to complement the hardware. DOE

**N88-11373#** GA Technologies, Inc., San Diego, Calif.
**NUMERICAL SIMULATION OF TOKAMAKS: IDEAL MHD EQUILIBRIUM AND STABILITY**
F. J. Helton Jul. 1987 9 p Presented at the 12th Conference on the Numerical Simulation of Plasmas, San Francisco, Calif., 20 Sep. 1987
(Contract DE-AC03-84ER-53158; GA Proj. 3411)
(DE87-013452; GA-A-18923; CONF-870947-4) Avail: NTIS HC A02/MF A01

Great improvements have been made in numerical techniques, and in the processing speed and storage capacity of new supercomputers. The advent of supercomputers has brought about a revolution in fields which deal with physical phenomena that are amenable to numerical solution. The technique of computer simulation has allowed many previously inaccessible phenomena to be studied and has been especially valuable for applications in areas for which experimentation is either impossible or expensive, for example building Tokamaks. Given the physics objectives of the Tokamak and the economic and engineering constraints of the design, then, using the appropriate realistic numerical simulation techniques, an engineering design can be decided. However, the unrealistic, hence incorrect, use of powerful numerical simulations can easily lead to Tokamak designs that will not be viable. In this paper remarks will be addressed only to the question of numerical simulation done for design purposes, clearly such remarks do not apply to theoretical studies in which theoretical (not necessarily realizable limits) are the major interest. DOE

**N88-11374#** California Inst. of Tech., Pasadena.
**BENCHMARKING THE CONNECTION MACHINE**
C. Baillie, E. Felten, and D. Walker 1987 9 p
(Contract DE-FG03-85ER-25009)
(DE87-013500; DOE/ER-25009/443) Avail: NTIS HC A02/MF A01

The purpose of this memo is to present the results of work done recently on the Connection Machine during a one-week visit by the authors to Thinking Machines Corporation. The main objectives of the trip were to benchmark the Connection Machine and to assess the software environment, in order to determine the suitability of the Connection Machine for solving computationally-intensive problems and to compare the Connection Machine with other highly-parallel computers. This report presents preliminary results, and describes the computer architecture. DOE

**N88-11375#** Argonne National Lab., Ill. Mathematics and Computer Science Div.
**EVALUATING COMPUTERS AND THEIR PERFORMANCE: PERSPECTIVES, PITFALLS, AND PATHS**
J. Dongarra, J. Martin, and J. Worlton Jun. 1987 24 p
(Contract W-31-109-eng-38)
(DE87-014264; ANL/MCS-TM-92) Avail: NTIS HC A03/MF A01

Various considerations relating to the evaluation of computer systems and their performance are presented with particular emphasis on the issue of benchmarking. In this context, the issue of workload analysis and the subsequent justification of benchmark authenticity based on correlation to the workload is discussed as

well as the need to limit variables in the analysis process. The objective has been to present a guide to some of the considerations and approaches involved in the benchmarking and performance evaluation of computers. Special attention will be given to supercomputers because of the extremely high cost associated with their development, procurement, and use as well as the urgent need of users to obtain the highest speeds possible for their computations. DOE

**N88-11376#** California Univ., Berkeley. Lawrence Berkeley Lab.
**THE IMPACT OF NEW COMPUTER TECHNOLOGY ON ACCELERATOR CONTROL**
E. Theil, V. Jacobson, and V. Paxson Apr. 1987 11 p Presented at the Particle Accelerator Conference, Washington, D.C., 16 Mar. 1987
(Contract DE-AC03-76SF-00098)
(DE87-014021; LBL-23232; CONF-870302-247) Avail: NTIS HC A03/MF A01

This paper describes some recent developments in computing and stresses their application in accelerator control systems. Among the advances that promise to have a significant impact are: (1) low cost scientific workstations; (2) the use of windows, pointing devices and menus in a multi-tasking operating system; (3) high resolution large-screen graphics monitors; and (4) new kinds of high bandwidth local area networks. The relevant features are related to a general accelerator control system. For example, this paper examines the implications of a computing environment which permits and encourages graphical manipulation of system components, rather than traditional access through the writing of programs or canned access via touch panels. DOE

**N88-11377#** Rockwell International Corp., Golden, Colo.
**PERSONAL COMPUTERS: A POWERFUL TOOL FOR PROJECT MANAGEMENT**
T. A. Hughes 1987 11 p Presented at the Instrument Society of America International Conference and Exhibit, Anaheim, Calif., 5 Oct. 1987
(Contract DE-AC04-76DP-03533)
(DE87-013381; RFP-4104; CONF-871028-4) Avail: NTIS HC A03/MF A01

Availability of low cost hardware and software within the past few years has made the Personal Computer a powerful tool for Project Management. Project managers very effectively apply word processing, cost accounting spreadsheets, and data management software to make their jobs easier. An important aspect of personal computers lies in their ability to improve productivity of the project design team. Project information can now be gathered, stored, and presented in a more useful form. Direct benefits are the detecting of cost overruns and scheduling problems through improved data analysis. This paper will discuss the use of Personal Computers in cost analysis, planning, tracking, and controlling instrumentation projects. Practical applications will be discussed and the advantages and disadvantages of available software will be reviewed. DOE

**N88-11378#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.
**THE MICROCOMPUTER AS AN ENGINEERING MANAGEMENT TOOL**
J. A. Goldsberry and T. R. Hoertkorn 1987 9 p Presented at the Society of Women Engineers National Convention, Kansas City, Mo., 24 Jun. 1987 Prepared in cooperation with DOE, Idaho Falls, Idaho
(Contract DE-AC07-76ID-01570)
(DE87-014882; EGG-M-37586; CONF-870669-2) Avail: NTIS HC A02/MF A01

Project management is a concern for engineers who need to track critical technical and financial data to accomplish tasks. Conservation personnel are currently using physical files to store project data. When data are needed, it is not always easily accessible. The manual approach is becoming increasingly difficult as the number of active projects increase. The mini-computer approach is functional but requires a large investment for hardware and software. Therefore, a microcomputer-based relational database management system (DBMS) is being implemented to improve operating efficiency and decision support for the Conservation Programs at INEL and the Conservation Technologies Division at DOE-ID. Managers and technical monitors can easily access the database to check the current status of projects. The application is designed to work in conjunction with a natural language inquiry product that allows retrieval of database information in plain English. DOE

**N88-11379#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**MEMORY SYSTEMS FOR SINGLE BUS MULTIPROCESSOR ARCHITECTURE. APPLICATION TO THE SCQM SYSTEM Ph.D. Thesis [SYSTEME MEMOIRE POUR ARCHITECTURE MULTIPROCESSEUR SUR BUS UNIQUE. APPLICATION AU SYSTEME SCQM]**
Michel Cekleov Sep. 1986 248 p In FRENCH
(ENST-86E022; ISSN-0751-1353; ETN-87-90660) Avail: NTIS HC A11/MF A01

The implementation of associated records to translate processor addresses in a single virtual memory space, the characterization and implementation of a single bus in a multiprocessor environment, the development of an algorithm to update the central memory from machine fore-memories, and the analysis of possible variants for MIMD strongly coupled multiprocessor architectures are discussed. The choices made are justified by experimental simulations. ESA

**N88-11380#** Oxford Univ. (England). Dept. of Engineering Science.
**MULTI-PROCESSOR ARCHITECTURES FOR ARTIFICIAL INTELLIGENCE PROCESSING**
J. G. Delgado-Frias and W. R. Moore Feb. 1987 27 p
(OUEL-1671/87; ETN-87-90967) Avail: NTIS HC A03/MF A01

Computer architectures for artificial intelligence (AI) applications are presented in order to determine an AI application that may be suitable for a 2-D array architecture on wafer scale integration technology. Functional programming oriented architectures, logic oriented architectures, and semantic networks are reviewed. ESA

**N88-11381#** Oxford Univ. (England). Dept. of Engineering Science.
**SOME 2-D WSI ARRAY ARCHITECTURES**
J. G. Delgado-Frias and W. R. Moore Feb. 1987 24 p
(OUEL-1672/87; ETN-87-90968) Avail: NTIS HC A03/MF A01

Three types of applications for a two-dimensional array to be implemented on wafer scale integration (WSI) technology are presented: image processing, numerical and finite element analysis, and artificial intelligence (AI). Although parallelism is a common feature the requirements on processing element capabilities and memory size are different. The advantages of AI applications, such as high parallelism, local communication and simple fault-tolerant schemes, and the WSI technology properties, small delays, high reliability, small size and low power, can be combined into a reliable, fast, and massively parallel 2-D array system. ESA

**N88-10797#** Centre National de la Recherche Scientifique, Toulouse (France).
**COMPUTING SYSTEMS DEPENDABILITY AND FAULT TOLERANCE: BASIC CONCEPTS AND TERMINOLOGY**
J. C. Laprie *In* AGARD, Fault Tolerant Considerations and Methods for Guidance and Control Systems Jul. 1987 15 p
(For primary document see N88-10796 02-08)
Copyright Avail: NTIS HC A07/MF A01

# 61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

**N88-11382*#** George Washington Univ., Washington, D.C. Dept. of Operations Research.
**SOFTWARE RELIABILITY MODELS FOR FAULT-TOLERANT AVIONICS COMPUTERS AND RELATED TOPICS Final Report, 1 Jul. 1981 - 30 Jun. 1987**
Douglas R. Miller 4 Nov. 1987 17 p
(Grant NAG1-179)
(NASA-CR-181440; NAS 1.26:181440) Avail: NTIS HC A03/MF A01 CSCL 09B

Software reliability research is briefly described. General research topics are reliability growth models, quality of software reliability prediction, the complete monotonicity property of reliability growth, conceptual modelling of software failure behavior, assurance of ultrahigh reliability, and analysis techniques for fault-tolerant systems. Author

**N88-11383*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**TUTORIAL AND HANDS-ON DEMONSTRATION OF A FLUENT INTERPRETER FOR CARE 3**
Anna L. Martensen (PRC Kentron, Inc., Hampton, Va.) and Salvatore J. Bavuso Nov. 1987 100 p Supersedes NASA-TM-85811
(NASA-TM-4011; L-16319; NAS 1.15:4011) Avail: NTIS HC A05/MF A01 CSCL 09B

This document updates one originally written as part of a workshop on the CARE 3 capability held at NASA Langley Research Center on February 22 to 24, 1984. Subsequent to the workshop, CARE 3 and its interface program were enhanced and extensive changes to the original document became necessary. This document, like its predecessor, is designed to illustrate the user interface capability and the salient CARE 3 features by describing various examples of reliability models and their solutions through the use of CARE 3. Author

**N88-11384#** DeLande Long (I. B. and M. A.) Software and Consultancy, Seeheim (West Germany).
**STUDY INTO A DATA RELAY SATELLITE MISSION ANALYSIS TOOL Final Report**
M. A. deLandeLong Paris, France ESA Jan. 1987 67 p Original contains color illustrations
(Contract ESOC-6432/85-D-JS(SC))
(ESA-CR(P)-2422; ETN-87-90883) Avail: NTIS HC A04/MF A01

Software to analyze the visibility between user spacecraft and data relay satellites (DRS) and collect user requirements for data transmission was produced. An optimization program ameliorates the traffic load on the various data links to fit the requirements of a set of user spacecraft contending simultaneously for the limited communications capacity of the DRS system. Graphics software produces animated sequences to present the results of the analysis and the optimization and to illustrate the principles of the DRS mission. The current version of the software may handle a system comprising up to 3 DRS's and 20 user spacecraft. ESA

**N88-11385#** Sandia National Labs., Albuquerque, N. Mex. Computer Sciences Dept.
**A DESIGN METHODOLOGY FOR THE UTILIZATION OF METRICS WITHIN VARIOUS PHASES OF SOFTWARE LIFECYCLE MODELS**
Guylaine M. Pollock and Sallie Sheppard (Texas A&M Univ., College Station.) 1987 22 p Presented at the 11th Annual International Computer Software and Applications Conference, Tokyo, Japan, 5 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-010519; SAND-86-2384C; CONF-871081-1) Avail: NTIS HC A03/MF A01

A design methodology for implementing an automatable set of elementary measures that can be used in constructing composite or hybrid software metric prototypes is presented. Metric kernel primitives developed with this methodology are utilized to construct new hybrid metrics that can be applied to programs implemented in different languages and to various phases of software lifecycle models. The primary intent of the methodology is to provide a technique and subsequent environment that will enhance research in the metric area. Initial evaluations of the design methodology have investigated the application of software complexity metrics to the maintenance phase of the traditional lifecycle model. Actual primitives have been developed in the Ada (TM) programming language to aid in constructing software complexity metrics. Prototypes of Halstead's metric and McCabe's Cyclomatic Complexity metric were constructed from the primitives to evaluate the design methodology. The prototypes can analyze programs written in either FORTRAN or COBOL. An environment to support the design methodology has been defined and is under development. DOE

**N88-11386#** California Univ., Davis.
**A PRELIMINARY TAXONOMY OF VISIBLE SURFACE ALGORITHMS**
C. W. Grant 10 Dec. 1986 5 p Presented at the Workshop on Rendering Algorithms and Systems Graphics, Toronto, Ontario, 5 Apr. 1987 Prepared in cooperation with Lawrence Livermore National Lab., Calif.
(Contract W-7405-eng-48)
(DE87-013559; UCRL-95810; CONF-8704194-1) Avail: NTIS HC A02/MF A01

Visibility determination is shown to be a common reoccurring subproblem in image synthesis. A preliminary taxonomy of visible surface algorithms is developed which is a superset of the taxonomy of Sutherland, Sproull, and Schumacker. Two major extensions are given. First, a three-dimensional structure based on sorting order is discovered for the point sampling class of algorithms. Second, an additional class of continuous sampling algorithms, not covered by Sutherland, Sproull, and Schumacker, is identified. Two main branches in this second class are identified: scan plane and subdivision algorithms. DOE

**N88-11387#** Fermi National Accelerator Lab., Batavia, Ill.
**THE VAXONLINE SOFTWARE SYSTEM AT FERMILAB**
V. White, P. Heinicke, E. Berman, P. Constanta-Fanourakis, B. MacKinnon, C. Moore, T. Nicinski, D. Petravick, R. Pordes, and L. Quigg Jun. 1987 6 p Presented at the 5th Conference on Real-Time Computer Applications in Nuclear, Particle and Plasma Physics, San Francisco, Calif., 11 May 1987
(Contract DE-AC02-76CH-03000)
(DE87-013565; FNAL/C-87/93; CONF-870552-23) Avail: NTIS HC A02

The VAXONLINE software system, started in late 1984, is now in use at 12 experiments at Fermilab, with at least one VAX or MicroVax. Data acquisition features now provide for the collection and combination of data from one or more sources, via a list-driven Event Builder program. Supported sources include CAMAC, FASTBUS, Front-end PDP-11's, Disk, Tape, DECnet, and other processors running VAXONLINE. This paper describes the functionality provided by the VAXONLINE system, gives performance figures, and discusses the ongoing program of enhancements. DOE

**N88-11388#** Lawrence Livermore National Lab., Calif.
**PRAXIS: THE PROGRAMMING LANGUAGE: AN ADVANCED OVERVIEW**
J. R. Greenwood, F. W. Holloway, C. R. Morgan, and A. Evans, Jr. Aug. 1987 30 p
(Contract W-7405-eng-48)
(DE87-014319; UCID-21056) Avail: NTIS HC A03/MF A01

Praxis is an Ada-like programming language developed for efficient programming of embedded control and systems

applications. It is strongly typed, and block structured in the tradition of Pascal and Ada, with efficiency and control similar to C. Praxis supports the development of systems composed of separately compiled modules, user defined data types, exception handling, and detailed data storage and control mechanisms. Direct access to machine facilities, efficient bit manipulation, and interlocked critical regions are also provided in Praxis. Praxis has been in operational use since late 1980, and current implementations for the VAX, PDP and LSI-11 computers have been released into the public domain. DOE

**N88-11389*#** Brown Univ., Providence, R. I. Div. of Engineering.
**CONCURRENT ALGORITHMS FOR TRANSIENT NONLINEAR FE ANALYSIS**
M. Ortiz [1987] 12 p
(Grant NAG1-634)
(NASA-CR-181455; NAS 1.26:181455) Avail: NTIS HC A03/MF A01 CSCL 09B

A two-parameter class of time-stepping algorithms for nonlinear structural dynamics is investigated. What sets the present method apart from other concurrent algorithms is the fact that it can be used to some advantage in sequential machines as well. Thus, substantial speed-ups are obtained on a single processor as the number of subdomains is increased. An additional O(p) speed-up is obtained when p processors are utilized. The test case discussed is being repeated for a mesh comprising four times as many elements, in an effort to understand how the large scale asymptotic speed-ups are attained. A three dimensional example involving finite deformations and free body motions is also being pursued. A code optimized for concurrency in the Alliant FX8 computer is being finalized. This will provide the means for testing the performance of the algorithm in a multiprocessor environment. B.G.

**N88-11390#** Stanford Univ., Calif. Systems Optimization Lab.
**USING MINOS (MODULAR IN-CORE NONLINEAR OPTIMIZATION SYSTEM) AS A SUBROUTINE FOR DECOMPOSITION**
Robert Entriken Jun. 1987 93 p
(Contract DE-FG03-87ER-25028)
(DE87-013086; SOL-87-7) Avail: NTIS HC A05/MF A01

This report is intended to provide a detailed knowledge of how MINOS can be used as a subroutine to solve optimization subproblems. The subproblems can be tasks of a higher order decision making framework. The scope of this paper is limited to the case where the subproblems are linear programs. Extension to the nonlinear case would naturally follow the same line of work done for the linear case. The details of MINOS are presented in three parts: How MINOS Works, a general description of the modules of the MINOS package (each module is treated as a black box which performs some functions independent of the others), MINOS as a Subroutine, details how to set up the data structures of a subproblem in the proper format so that the optimization black box may solve it, and Decomposition with MINOS where nested-dual decomposition is used as a sophisticated example of how to create, modify and solve a sequence of different subproblems. This final part of the report is basically a description of a software package called DECOMP, which acts as a main program calling MINOS as a subroutine. DOE

**N88-11391#** California Univ., Berkeley. Lawrence Berkeley Lab.
**PROJECTION-SPACE ITERATIVE INTERPOLATION FOR LIMITED-ANGLE TOMOGRAPHY IN PARALLEL- AND FAN-BEAM GEOMETRY, PART 1**
K. Heiskanen, Jong-Jin Wang, and V. Perez-Mendex May 1987 15 p
(Contract DE-AC03-76SF-00098)
(DE87-013965; LBL-23505-Pt-1) Avail: NTIS HC A03/MF A01

In computed tomography one reconstructs the image of an object from its projections. The limited-angle tomography problem arises when the number of projections available is too small, or the projections are not obtained from all angles around the object, evenly enough distributed. Such is the case, when the object moves while the projections are measured, for example CT - scanning the beating heart. A new algorithm, the projection-space iterative reconstruction reprojection (PSIRR), estimates the missing projection data from the known data. This method is valid for parallel-beam projections only. In this paper their method is further modified and discussed. A similar iterative interpolation algorithm is derived for estimating missing projection data in fan-beam geometry. DOE

**N88-11392#** Stanford Univ., Calif. Systems Optimization Lab.
**AN ANALYSIS OF AN AVAILABLE SET OF LINEAR PROGRAMMING TEST PROBLEMS**
Irvin J. Lustig Aug. 1987 55 p
(Contracts DE-FG03-87ER-25028; DE-FG03-87ER-25030)
(DE87-014578; SOL-87-11) Avail: NTIS HC A04/MF A01

A set of linear programming test problems is analyzed with MINOS, Version 5.1. The problems have been run with different options for scaling and partial pricing to illustrate the effects of these options on the performance of the simplex method. The results indicate that the different options can significantly improve or degrade the performance of the simplex method, and that these options must be chosen wisely. For each problem a picture of the nonzero structure of the matrix A is also presented so that the problems can be classified according to structure. DOE

**N88-11393#** Oak Ridge National Lab., Tenn.
**IMPLEMENTATION AND EVALUATION OF SEVERAL CONTINUOUSLY IMBEDDED METHODS OF SARAFYAN**
S. Thompson Aug. 1987 34 p
(Contract DE-AC05-84OR-21400)
(DE88-000025; ORNL/TM-10434) Avail: NTIS HC A03/MF A01

Several of Sarafyan's continuously imbedded methods have been implemented and evaluated. This study discusses several important implementation questions and presents results that demonstrate the effectiveness of the resulting software. The results indicate that Sarafyan's methods are well-suited for the solution of ordinary differential equations requiring rootfinding to handle special events and interpolation for dense output. The results further indicate that the software based on several of the higher order methods is competitive with other widely-used general purpose Runge-Kutta software. DOE

**N88-11394#** Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Systemes et Communications.
**WEIGHTED DECODING OF BLOCK CODES AND SOME TOPICS ON DECODING COMPLEXITY Ph.D. Thesis [DECODAGE PONDERE DES CODES EN BLOCS ET QUELQUES SUJETS SUR LA COMPLEXITE DU DECODAGE]**
Juing Fang Mar. 1987 149 p Partly in FRENCH and ENGLISH
(ENST-87E005; ISSN-0751-1353; ETN-87-90661) Avail: NTIS HC A07/MF A01

The theoretical complexity of decoding, algorithm analysis, probabilistic algorithms and analysis, performance/complexity trade-off and suboptimal algorithms, time-space trade-off and fast processing structures, and complexity of decoder are discussed. The NP completeness of the problem of the general soft decision decoding of linear codes is demonstrated. A relationship between the complexities of decoding and the problem of computing the minimum distance of linear codes is found. ESA

**N88-11395#** Toulouse Univ. (France). Lab. d'Automatique et d'Analyse des Systemes.
**CONTRIBUTION TO THE DEVELOPMENT OF SMART DESIGN TECHNIQUES FOR VLSI INTEGRATED CIRCUITS Ph.D. Thesis - Paul Sabatier Univ.**
Etienne Sicard 1987 138 p In FRENCH; ENGLISH summary
(LAAS-87-181; ETN-87-90915) Avail: NTIS HC A07/MF A01

Computer aided design techniques based on expert systems and artificial intelligence are presented. The theory of design automation is developed and algorithms are presented. The application of these ideas to the design of an n x m multiplier illustrates the potential of the method. ESA

**N88-11396#** MATRA Espace, Paris-Velizy (France). Space Branch.
**PROTOTYPE RENDEZVOUS ONBOARD SOFTWARE (PROBS) Final Report**
Paris, France ESA Dec. 1986 54 p
(Contract ESA-5993/84-NL-AN(SC))
(Matra-EPT-DT-PRB-2A-00068; ESA-CR(P)-2428; ETN-87-90919)
Copyright Avail: NTIS HC A04/MF A01

The Prototype Rendezvous Onboard Software (PROBS) was established on the basis of a LEO rendezvous (RVD) mission selected in order to involve the most complex automatic scenario (RVD with a Sun-pointed spacecraft, e.g., EURECA, which is only passively cooperative, i.e., does not participate in the RVD maneuver) in order to be easily adapted to any autonomous RVD mission. The software includes sensor data processing; estimation and control of chaser absolute/relative position and attitude; sequencing of modes; interfaces with equipments and platform controller; and failure detection, isolation, and recovery. The software was developed according to the ESA BSSC standard, and is coded in C-language. ESA

**N88-11397#** Rolls-Royce Ltd., Derby (England).
**COMPUTER AIDED ENGINEERING/MANUFACTURING AT ROLLS-ROYCE**
D. Gale and A. H. Waddicor 24 Mar. 1987 9 p Presented at the I Mech E Computers in Engine Technology International Conference, Cambridge, United Kingdom, 24-27 Mar. 1987
(PNR90395; ETN-87-90998) Copyright Avail: NTIS HC A02/MF A01

The use of technical computing power within the aerospace product definition process, from piston engines to the present, is reviewed. Opportunities and strategies for the use of future computer based developments in the product process are discussed. ESA

**N88-11398*#** Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
**CACHE-BASED ERROR RECOVERY FOR SHARED MEMORY MULTIPROCESSOR SYSTEMS**
Kun-Lung Wu, W. Kent Fuchs, and Janak H. Patel 20 Nov. 1987 21 p Presented at FTCS 18, Tokyo, Japan, 27-30 Jun. 1987 Sponsored in cooperation with Texas Instruments, Inc. and Digital Equipment Corp.
(Grant NAG1-613)
(NASA-CR-181470; NAS 1.26:181470) Avail: NTIS HC A03/MF A01 CSCL 09B

The problem of recovering from processor failures in shared memory multiprocessor systems is examined. A cache-based checkpointing scheme is developed utilizing a checkpointing algorithm which guarantees that a consistent global state is always maintained. Processes can recover from errors due to a faulty processor by restarting from the consistent saved computation state. There are no difficulties with checkpoint propagation in that when a process p takes a checkpoint, no other process is forced to join p in the checkpoint. The recovery algorithm allows only those processes encountering errors to perform rollback recovery while other unaffected processes on fault free processors continue normal execution. The checkpointing recovery schemes are shown to be easily integrated into standard bus-based cache coherence protocols. An analytical model is used to estimate the checkpointing frequency and the performance degradation incurred by the checkpointing scheme during normal execution. Author

**N88-10816#** Electronique Serge Dassault, St. Cloud (France).
**HOW TO USE PROLOG FOR EXPERT SYSTEM PROGRAMMING**
Michel Muenier, Patrick Taillibert, and Serge Varennes *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 8 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

**N88-10817#** Carleton Univ., Ottawa (Ontario). Dept. of Systems and Computer Engineering.
**REAL-TIME EXPERT SYSTEMS: A STATUS REPORT**
B. A. Bowen *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 15 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

**N88-11165*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**3-D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS**
E. S. Todd *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 239-243 (For primary document see N88-11140 02-39)
(Contract NAS3-23697)
Avail: NTIS HC A19/MF A01 CSCL 09B

**N88-11166*#** General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
**COMPONENT SPECIFIC MODELING**
R. L. McKnight and M. T. Tipton *In* NASA. Lewis Research Center, Turbine Engine Hot Section Technology, 1985 Oct. 1985 p 245-257 (For primary document see N88-11140 02-39)
(Contract NAS3-23687)
Avail: NTIS HC A19/MF A01 CSCL 09B

# 62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

**N88-11399*#** University of Southern Mississippi, Hattiesburg. Coll. of Science and Technology.
**USING BIBLIOGRAPHIC DATABASES IN TECHNOLOGY TRANSFER**
G. David Huffman Oct. 1987 235 p Sponsored by NASA
(NASA-CR-181403; NAS 1.26:181403) Avail: NTIS HC A11/MF A01 CSCL 09B

When technology developed for a specific purpose is used in another application, the process is called technology transfer--the application of an existing technology to a new use or user for purposes other than those for which the technology was originally intended. Using Bibliographical Databases in Technology Transfer deals with demand-pull transfer, technology transfer that arises from need recognition, and is a guide for conducting demand-pull technology transfer studies. It can be used by a researcher as a self-teaching manual or by an instructor as a classroom text. A major problem of technology transfer is finding applicable technology to transfer. Described in detail is the solution to this problem, the use of computerized, bibliographic databases, which currently contain virtually all documented technology of the past 15 years. A general framework for locating technology is described. NASA technology organizations and private technology transfer firms are listed for consultation. Author

**N88-11400#** Illinois Univ., Urbana. Dept. of Computer Science.
**IMPLEMENTATION OF PRECONDITIONED s-STEP CONJUGATE GRADIENT METHODS ON A MULTIPROCESSOR SYSTEM WITH MEMORY HIERARCHY**
A. T. Chronopoulos and C. W. Gear Aug. 1987 30 p
(Contract DE-FG02-87ER-25026)
(DE87-014401; DOE/ER-25026/9; UIUCDCS-R-87-1347; UILU-ENG-87-1750) Avail: NTIS HC A03/MF A01

Multiprocessor architectures combining vector and parallel processing capabilities on a two-level shared memory structure have been implemented. This memory hierarchy structure requires that numerical algorithms possess good data locality in order to achieve high performance rates. The s-step Conjugate Gradient

method is a generalization of the classical method with improved data locality and parallel properties. Numerical experiments on a multiprocessor with memory hierarchy show the superiority in performance of the s-step methods to their one-step counterparts. DOE

**N88-11401#** Oxford Univ. (England). Dept. of Engineering Science.
**SEMANTIC NETWORK PROCESSING SYSTEMS**
J. G. Delgado-Frias and W. R. Moore Jun. 1987 29 p Sponsored by the ALVEY program project ARCH 019
(OUEL-1677/87; ETN-87-90971) Avail: NTIS HC A03/MF A01

The NETL, connection machine, semantic network array processor, parallel network wave machine, data flow, semantic network processing system, frames, and Boltzmann machine approaches to knowledge oriented systems are described. Artificial intelligence processing features that influence the design of semantic network systems are discussed. The possibilities of wafer scale integration technology are mentioned. ESA

**N88-11402*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**REPORT FROM THE MPP WORKING GROUP TO THE NASA ASSOCIATE ADMINISTRATOR FOR SPACE SCIENCE AND APPLICATIONS Technical Memorandum Report, 1 Oct. 1985 - 30 Sep. 1986**
James R. Fischer, Chester Grosch, Michael McAnulty, John ODonnell, and Owen Storey (Stanford Univ., Calif.) Nov. 1987 64 p
(NASA-TM-87819; Rept-87B0265; NAS 1.15:87819) Avail: NTIS HC A04/MF A01 CSCL 09B

NASA's Office of Space Science and Applications (OSSA) gave a select group of scientists the opportunity to test and implement their computational algorithms on the Massively Parallel Processor (MPP) located at Goddard Space Flight Center, beginning in late 1985. One year later, the Working Group presented its report, which addressed the following: algorithms, programming languages, architecture, programming environments, the way theory relates, and performance measured. The findings point to a number of demonstrated computational techniques for which the MPP architecture is ideally suited. For example, besides executing much faster on the MPP than on conventional computers, systolic VLSI simulation (where distances are short), lattice simulation, neural network simulation, and image problems were found to be easier to program on the MPP's architecture than on a CYBER 205 or even a VAX. The report also makes technical recommendations covering all aspects of MPP use, and recommendations concerning the future of the MPP and machines based on similar architectures, expansion of the Working Group, and study of the role of future parallel processors for space station, EOS, and the Great Observatories era. Author

# 63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

**N88-11403#** Michigan State Univ., East Lansing.
**SYNTHESIZING CONTROLLERS FOR UNCERTAIN SYSTEMS BY A QUANTITATIVE POLE-PLACEMENT Final Report, 1 Jun. 1984 - 30 Nov. 1986**
S. Jayasuriya Feb. 1987 149 p
(Grant NSF MEA-84-04324)
(PB87-195590; NSF/ENG-87002) Avail: NTIS HC A07/MF A01 CSCL 09B

Three objectives are given for this research on synthesizing controllers for uncertain systems: (1) the study of different formulations of the tracking problem for uncertain systems incorporating a global concept of tracking; (2) a consideration of different controller structures that allow precision tracking, and are simple i.e., a pole-placement technique that is quantitative in nature; and (3) to apply the results of 1 and 2 to a robot manipulator problem. GRA

**N88-11404#** Oak Ridge National Lab., Tenn.
**ROBOTICS AND INTELLIGENT SYSTEMS PROGRAM**
Jun. 1987 14 p
(Contract DE-AC05-84OR-21400)
(DE87-014561; ORNL/M-358) Avail: NTIS HC A03/MF A01

This report gives brief descriptions of the projects associated with the Robotics and Intelligent Systems Program (RISP). Projects included in the report are: (1) Remote Operations Demonstration Facility; (2) M-2 Servomanipulator; (3) the Advanced Servomanipulator; (4) Hostile Environment Robotic Machine Intelligence Experiment Series (robots); and (5) Telerobotic Concepts. These devices have application in nuclear industry and space environments. DOE

**N88-11405#** Toulouse Univ. (France). Lab. d'Automatique et d'Analyse des Systemes.
**STUDY OF CLOSED LOOP CONTROL SINGULARITY IN DYNAMIC SYSTEMS WITH A CONSTRAINT ON THE FINAL STATE Ph.D. Thesis - Paul Sabatier Univ.**
Gerard Montseny 1987 140 p In FRENCH; ENGLISH summary
(LAAS-87-180; ETN-87-90914) Avail: NTIS HC A07/MF A01

Feedback singularities in closed loop controlled dynamic systems are studied and a strategy to avoid control numerical instability is presented. The concepts of ill posed problems and regularization were used as formal tools. A numerical simulation of a parabolic distributed parameter system illustrates the possibilities of the described technique. ESA

**N88-11406#** Oxford Univ. (England). Dept. of Engineering Science.
**EXTENSIONS OF THE SMALL mu TEST FOR ROBUST STABILITY**
Yung Kuan Foo and Ian Postlethwaite 1987 26 p Revised Sponsored by the United Kingdom Science and Engineering Council
(OUEL-1666/87-Rev; ETN-87-90966) Avail: NTIS HC A03/MF A01

The notion of a topologically arcwise connected set is used to develop a general graph-topology based robustness test. The test provides a switching criterion among different inequality tests, and possibly among different nominal models. When applied to extend the small-mu test of a feedback control system subjected to multiple perturbations, the result reduces conservatism and enables a more natural application of the small-mu test. ESA

**N88-11407#** Oxford Univ. (England). Dept. of Engineering Science.
**A TREATMENT OF jw-AXIS MODEL-MATCHING TRANSFORMATION ZEROS IN THE OPTIMAL H SQUARED AND H INFINITY CONTROL DESIGNS**
S. D. OYoung, I. Postlethwaite, and D.-W. Gu 1987 27 p Sponsored by the United Kingdom Science and Engineering Council
(OUEL-1673/87; ETN-87-90969) Avail: NTIS HC A03/MF A01

A model-matching transformation (MMT) zero is defined as a rank-deficiency condition which prevents an Hsq or H sup inf optimal control problem from being transformed into an equivalent model-matching problem. By imposing saturation constraints and accounting for additive instrument noise in the sensor and actuator signals, all MMT zeros can be eliminated. This is attained at the cost of making the underlying Hsq or H sup inf optimization problem generically 4-block. ESA

**N88-10813#** Centre de Recherches de la Compagine Generale d'Electricite, Marcoussis (France).
**GENERATING DIAGNOSTIC KNOWLEDGE FROM A STRUCTURAL AND FUNCTIONAL DESCRIPTION**
Jean-Pascal Aubert, Jean-Michel Cornille, and Alain Meller *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 4 p Sponsored by French Defense Ministry (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

**N88-10814#** Lear Siegler, Inc., Grand Rapids, Mich. Instrument and Avionic Systems Div.
**A REVIEW OF THE KNOWLEDGE ENGINEERING PROCESS**
Michael W. Bird *In* AGARD, Knowledge Based Concepts and Artificial Intelligence: Applications to Guidance and Control Aug. 1987 12 p (For primary document see N88-10806 02-08)
Copyright Avail: NTIS HC A07/MF A01

# 64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

**N88-11408#** Lawrence Livermore National Lab., Calif.
**DIFFERENCING THE DIFFUSION EQUATION ON A MESH OF TRIANGLES AND QUADRILATERALS**
William E. Zagotta and Dennis M. Braddy Jan. 1987 9 p Presented at the Nuclear Science and Engineering Conference, Paris, France, 1 May 1987
(Contract W-7405-eng-48)
(DE87-011550; UCRL-95888; CONF-8705169-2) Avail: NTIS HC A02/MF A01

A finite differencing method has been derived, which is capable of solving the diffusion equation on a Lagrangian mesh consisting of an arbitrary mixture of quadrilaterals and triangles. Results have been presented that show that when run on similar problems, similar performance is achieved compared to other state-of-the-art codes. DOE

**N88-11409#** Lawrence Livermore National Lab., Calif.
**ON THE RELATIONAL MODELING OF DISCRETE PDE PROBLEMS**
D. Balaban, J. Garbarini, K. Olwell, W. Greiman, and S. Shlaer 1987 67 p Presented at the International Symposium on AI, Expert Systems and Languages in Modelling and Simulation, Barcelona, Spain, 2 Jun. 1987 Prepared in cooperation with Project Technology, Inc., Berkeley, Calif.
(Contract W-7405-eng-48)
(DE87-013336; CONF-8706178-1) Avail: NTIS HC A04/MF A01

A knowledge representation scheme for discrete partial differential equation (PDE) problems has been created which makes possible the mechanical creation of simulation programs. This knowledge representation scheme is based on: three fundamental relations between observables, densities, currents, and sources which provide a framework for a large class of physics problems; and partitioning spacetime to provide a framework for defining a discrete system of equations by specifying approximations to spacetime current integrals on spacetime partitions. DOE

**N88-11410#** California Inst. of Tech., Pasadena.
**FINITE ELEMENTS FOR 2D ELLIPTIC EQUATIONS WITH MOVING NODES**
R. D. Williams 1987 20 p
(Contract DE-FG03-85ER-25009)
(DE87-013501; DOE/ER-25009/423) Avail: NTIS HC A03/MF A01

A Finite Element algorithm for minimizing a homogeneous variational principle which is a quadratic in the function derivatives is described. The minimization is with respect to the (possibly vector-valued) function at the nodes, and also with respect to the nodal positions and the connectivity of the mesh. The elements are linear triangles, the mesh is automatically generated, and may be locally refined if a user-supplied refinement criterion is satisfied. The problem domain may have arbitrary shape, but must have the topology of a disk, and either Dirichlet or Neumann conditions may be specified at each point of the boundary. An example is given of a problem from elasticity theory. DOE

**N88-11411#** Oak Ridge National Lab., Tenn.
**EXTENDING GREEN'S FUNCTION FORMALISM TO GENERAL NONLINEAR EQUATIONS**
D. G. Cacuci, R. B. Perez, and V. Protopopescu 1987 10 p Presented at the 4th Workshop on Nonlinear Evolution Equations and Dynamical Systems, Montpellier, France, 11 Jun. 1987
(Contract DE-AC05-84OR-21400)
(DE87-013541; CONF-870633-1) Avail: NTIS HC A02/MF A01

Forward and backward propagators are canonically obtained for general nonlinear problems and shown to be the natural generalizations of the Green's functions used to solve linear problems. The propagators obey a reciprocity relationship and satisfy a closed nonlinear integral equation. The formalism is applied on an illustrative example. DOE

**N88-11412#** Brookhaven National Lab., Upton, N. Y.
**A GENERAL APPROACH TO ERROR PROPAGATION**
J. B. Sanborn 1987 7 p Presented at the 28th INMM Annual Meeting on Safeguards: A Mature Technology, Newport Beach, Calif., 12 Jul. 1987
(Contract DE-AC02-76CH-00016)
(DE87-014287; BNL-40118; CONF-870713-55) Avail: NTIS HC A02

A computational approach to error propagation is explained. It is shown that the application of the first-order Taylor theory to a fairly general expression representing an inventory or inventory-difference quantity leads naturally to a data structure that is useful for structuring error-propagation calculations. This data structure incorporates six types of data entities: (1) the objects in the material balance, (2) numerical parameters that describe these objects, (3) groups or sets of objects, (4) the terms which make up the material-balance equation, (5) the errors or sources of variance, and (6) the functions or subroutines that represent Taylor partial derivatives. A simple algorithm based on this data structure can be defined using formulas that are sums of squares of sums. The data structures and algorithms described above have been implemented as computer software in FORTRAN for IBM PC-type machines. A free-form data-entry format allows users to separate data as they wish into separate files and enter data using a text editor. The program has been applied to the computation of limits of error for inventory differences (LEIDs) within the DOE complex. DOE

**N88-11413#** Stanford Univ., Calif. Systems Optimization Lab.
**COMPUTATIONAL BEHAVIOR OF GAUSS-NEWTON METHODS**
C. Fraley Aug. 1987 50 p
(Contract DE-FG03-87ER-25030)
(DE87-014486; SOL-87-10) Avail: NTIS HC A03/MF A01

This paper is concerned with the numerical behavior of Gauss-Newton methods for nonlinear least-squares problems. Here we assume that the defining feature of a Gauss-Newton method is that the direction from one iterate to the next is the numerical solution of a particular linear least-squares problem, with a steplength subsequently determined by a linesearch procedure. It is well known that Gauss-Newton methods cannot be successfully applied to nonlinear least-squares problems as a class without modification. Our purpose is to give specific examples illustrating some of the difficulties that arise in practice which we believe have not been fully described in the literature. DOE

**N88-11414*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**AN ADAPTIVE PSEUDO-SPECTRAL METHOD FOR REACTION DIFFUSION PROBLEMS**

A. Bayliss, D. Gottlieb, B. J. Matkowsky, and M. Minkoff (Argonne National Lab., Ill.) Oct. 1987 43 p Submitted for publication
(Contracts NAS1-18107; W-31-109-eng-38; DE-FG02-87ER-25027; Grants NSF DMS-87-01543; AF-AFOSR-0303-85)
(NASA-CR-178394; ICASE-87-67; NAS 1.26:178394) Avail: NTIS HC A03/MF A01 CSCL 12A

The spectral interpolation error was considered for both the Chebyshev pseudo-spectral and Galerkin approximations. A family of functionals I sub r (u), with the property that the maximum norm of the error is bounded by I sub r (u)/J sub r, where r is an integer and J is the degree of the polynomial approximation, was developed. These functionals are used in the adaptive procedure whereby the problem is dynamically transformed to minimize I sub r (u). The number of collocation points is then chosen to maintain a prescribed error bound. The method is illustrated by various examples from combustion problems in one and two dimensions. Author

**N88-11415#** Brookhaven National Lab., Upton, N. Y. Applied Mathematics Dept.
**PRECONDITIONED ITERATIVE METHODS APPLIED TO SINGULARLY PERTURBED ELLIPTIC BOUNDARY VALUE PROBLEMS: VOLUME 2**
Charles I. Goldstein Jan. 1987 58 p
(Contract DE-AC02-76CH-00016)
(DE87-014337; BNL-51916-Vol-2) Avail: NTIS HC A04/MF A01

It is the purpose of this report to modify and extend results in a previous report, concerning a class of multigrid preconditioners developed for use in the iterative solution of singularly perturbed elliptic boundary value problems. Typically, the low order derivative terms are multiplied by a large parameter, K. The preconditioner was based on a partial multigrid V cycle applied to the discrete LaPlacian, - delta sup h, where h is the grid size. By this, we mean that the coarse grid residual problem is not solved. At most, one or a few relaxation sweeps are applied on this grid level. The multigrid preconditioner is now extended to include the W cycle applied to - delta sup h as well as - delta sup h + K squared. It is shown how to choose the coarsest grid size as a function of K, h, and the type of multigrid cycle in order to obtain optimal convergence of the preconditioned iterative method. It is proved that the low frequency subspace is scaled by 0(K-2) for both the V and W cycles. For the W cycle, it is proved that the multigrid preconditioner is norm equivalent to (- delta sup h + K-squared) -1, uniformly in both K and h. The results are proved using Fourier analysis. DOE

**N88-11416#** Department of Energy, Washington, D. C. Office of Energy Research.
**SUMMARIES OF THE FY 1987 APPLIED MATHEMATICAL SCIENCES RESEARCH PROGRAM**
Aug. 1987 61 p
(DE87-014447; DOE/ER-0342) Avail: NTIS HC A04/MF A01

The purpose of this report is to provide a convenient compilation of summaries of the individual research projects that constitute the Applied Mathematical Sciences research subprogram managed by the Director, Scientific Computing Staff, Office of the Director of Energy Research, Department of Energy. This office, organized in 1984, consists of the Applied Mathematical Sciences Research activity formerly under the Division of Engineering, Mathematical and Geosciences, Office of Basic Energy Sciences, Office of Energy Research, and the management of the Energy Sciences Advanced Computation activity. The areas included in this report are: analytical and numerical methods, information analysis techniques, advanced computing concepts, energy science advanced computation and capital equipment. DOE

**N88-11417#** International Centre for Theoretical Physics, Trieste (Italy).
**ON OSCILLATION OF A KIND OF INTEGRO-DIFFERENTIAL EQUATION WITH DELAY**
Binggen Zhang Nov. 1986 9 p
(DE87-703059; IC-86/296) Avail: NTIS (US Sales Only) HC A02/MF A01

A sufficient condition is obtained for the oscillation of a kind of integro-differential equation with delay. DOE

**N88-11418#** International Centre for Theoretical Physics, Trieste (Italy).
**OSCILLATORY AND NONOSCILLATORY PROPERTIES OF FIRST ORDER DIFFERENTIAL EQUATIONS WITH PIECEWISE CONSTANT DEVIATING ARGUMENTS**
B. G. Zhang and N. Parhi Nov. 1986 16 p
(DE87-703061; IC-86/307) Avail: NTIS (US Sales Only) HC A03/MF A01

In this paper, sufficient conditions have been obtained for oscillation and non-oscillation of solutions of first order differential equations with piecewise constant deviating arguments. These equations occur in mathematical models of certain biomedical problems. DOE

**N88-11419#** International Centre for Theoretical Physics, Trieste (Italy).
**DIRECTION DEPENDENT CONNECTIONS OF COMPLEX MANIFOLDS AND THEIR SUBMANIFOLDS**
S. C. Rastogi Nov. 1986 21 p
(DE87-703073; IC-86/335) Avail: NTIS (US Sales Only) HC A03/MF A01

By using the method of calculus of variations in 1967, Rund introduced a generalized metric on complex manifold. He also defined direction dependent connections on such manifolds. Later on in 1972, Rund introduced general direction dependent connections on complex manifolds. Based on these connection coefficients he defined curvature and torsion tensors and obtained some interesting results in case of metric connections. The aim of this paper is to study submanifolds of such complex manifolds. In this paper I have defined induced and intrinsic connections and curvature tensors based on them. Besides this, equations analogous to Gauss-Codazzi have been obtained for both induced and intrinsic connections. In the end some applications of these results are given by studying submanifolds of complex manifolds of isotropic curvature. DOE

**N88-11420#** International Centre for Theoretical Physics, Trieste (Italy).
**IRREDUCIBLE *-REPRESENTATIONS OF THE LIE SUPERALGEBRA osp(1,4) WITH FINITE-DEGENERATED VACUUM**
J. Blank and M. Havlicek Nov. 1986 27 p
(DE87-703089; IC-86/377) Avail: NTIS (US Sales Only) HC A03/MF A01

The method presented previously is applied to the Lie superalgebra B(0,2). A family of irreducible *-representations of this superalgebra and its real form osp(1,4) in terms of differential operators is obtained, the dimension of the vacuum subspace of pi sub J being J+1. Reduction with respect to the subalgebra sp(4,IR) approx.= so(3,2) is performed: the representation pi sub O reduces into three irreducible representations of so(3,2), whereas all the other pi sub J into two. DOE

**N88-11421#** International Centre for Theoretical Physics, Trieste (Italy).
**FINITE-DIMENSIONAL MATRIX REPRESENTATION OF THE DIFFERENTIAL OPERATOR, DETERMINENTAL FORM AND ZEROS OF SPECIAL FUNCTIONS**
T. S. Santhanam and R. Jagannathan Dec. 1986 13 p
(DE87-703091; IC-86/379) Avail: NTIS (US Sales Only) HC A03/MF A01

Finite dimensional matrix representations of differential operators are discussed. The determinental form of polynomials is used to relate their zeros to the eigenvalues of Jacobi's tridiagonal matrix for the case of special functions. The distribution of these zeros is analyzed. DOE

**N88-11422#** International Centre for Theoretical Physics, Trieste (Italy).
**NEW CLASS OF SPHERICALLY SYMMETRIC INTERIOR SOLUTION WITH COSMOLOGICAL CONSTANT**
Chongming Xu, Xuejun Wu, and Zhun Huang Dec. 1986 9 p
(DE87-703095; IC-86/392) Avail: NTIS (US Sales Only) HC A02/MF A01

In this paper, a new class of spherically symmetric interior solution with cosmological constant lambda is obtained, to which Florides' solution is extended. As a special case, the metric in uniform proper density is discussed. The Robson junction condition is also extended to the case with lambda, which is a set of necessary and sufficient condition for a spherically symmetric metric to join smoothly onto the vacuum metric at a nonnull boundary surface. The new solution satisfies the extended Robson condition. DOE

**N88-11423#** Sandia National Labs., Albuquerque, N. Mex.
**THE METHOD OF LINES FOR TIME DEPENDENT FREE BOUNDARY PROBLEMS**
D. E. Womble 1987 40 p Presented at the NASIG Meeting, Truckee, Calif., 21 Sep. 1987
(Contract DE-AC04-76DP-00789)
(DE87-013929; SAND-87-1380C; CONF-8709123-1) Avail: NTIS HC A03/MF A01

The method of lines is used to semi-discretize a time dependent free boundary problem. The resulting ordinary differential equations are solved and an approximate solution to the continuous problem is constructed. In the case of the moving contact problem, a variational inequality form of the problem exists and the variational inequality can be used to prove the convergence of the approximate solution to the true solution. As a numerical example, the solidification of a binary alloy natural convection is presented. DOE

**N88-11424#** Illinois Univ., Urbana. Dept. of Computer Science.
**COMPUTATIONAL METHODS AND SOFTWARE FOR DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS Annual Report, 1 Dec. 1986 - 30 Nov. 1987**
C. W. Gear and R. D. Skeel Aug. 1987 18 p
(Contract DE-FG02-87ER-25026)
(DE87-014601; DOE/ER-25026/8) Avail: NTIS HC A03/MF A01

This paper contains the annual report and continuing proposals on computational methods for differential equations. The areas of specific consideration are: parallel and waveform methods for ODE and analysis and development of ODE methods. DOE

**N88-11425#** Illinois Univ., Urbana. Dept. of Computer Science.
**PARALLEL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS**
C. W. Gear Aug. 1987 31 p
(Contract DE-FG02-87ER-25026)
(DE87-014667; DOE/ER-25026/11; UILU-ENG-87-1754) Avail: NTIS HC A03/MF A01

Remarkably few methods have been proposed for the parallel integration of ordinary differential equations (ODEs). In part this is because the problems do not have much natural parallelism (unless they are virtually uncoupled systems of equations, in which case the method is obvious). In part it is because the subproblems arising in the solution of ODEs (for example, the solution of linear equations) are the ones that have provided the challenges for parallelism. This paper surveys some of the methods that have been proposed, and suggests some additional methods that are suitable for special cases, such as linear problems. It then looks at the possible application of large-scale parallelism, particularly across the method. If efficiency is of no concern (that is, if there is an arbitrary number of processors) there are some ways in which the solution of stiff equations can be done more rapidly, in fact, a speed up from a parallel time of $O(N^2)$ to $O(\log N)$ for N equations might be possible if communication time is ignored. This is obtained by trying to perform as much as possible of the matrix arithmetic associated with the solution of the linear equations at each step in advance of that step and in parallel with the integration of earlier steps. DOE

**N88-11426#** Oak Ridge National Lab., Tenn. Engineering Physics and Mathematics Div.
**ITERATIVE SOLUTION OF A NONLINEAR SYSTEM ARISING IN PHASE CHANGE PROBLEMS**
M. A. Williams Aug. 1987 84 p
(Contract DE-AC05-84OR-21400)
(DE87-014672; ORNL-6398) Avail: NTIS HC A05/MF A01

This paper considers several iterative methods for solving the nonlinear system arising from an enthalpy formulation of a phase change problem. Implicit discretization of the governing equations results in a mildly nonlinear system at each time step. We discuss solving this system using Jacobi, Gauss-Seidel, and SOR iterations and a new modified preconditioned conjugate gradient (MPCG) algorithm. The new MPCG algorithm and its properties are discussed in detail. Numerical results are presented comparing the performance of the SOR algorithm and the MPCG algorithm with 1-step SSOR preconditioning. The MPCG algorithm exhibits a superlinear rate of convergence. The SOR algorithm exhibits a linear rate of convergence. Thus, the MPCG algorithm requires fewer iterations to converge than the SOR algorithm. However, in most cases, the SOR algorithm requires less total computation time than the MPCG algorithm. Hence, the SOR algorithm appears to be more appropriate for the class of problems considered. DOE

**N88-11427#** Oak Ridge National Lab., Tenn.
**IMPSOR: A FULLY VECTORIZED FORTRAN CODE FOR THREE DIMENSIONAL MOVING BOUNDARY PROBLEMS WITH DIRICHLET OR NEUMANN BOUNDARY CONDITIONS**
W. A. Williams and D. G. Wilson Aug. 1987 38 p
(Contract DE-AC05-84OR-21400)
(DE87-014964; ORNL-6393) Avail: NTIS HC A03/MF A01

This report documents IMPSOR, a FORTRAN code that implements finite difference methods for multidimensional moving boundary problems with Dirichlet or Neumann boundary conditions on a Cray X-MP. The geometry of the spatial domain is a rectangular parallelepiped. The dimensions of the parallelepiped are specified by the user. Dirichlet or Neumann boundary conditions may be specified on each face of the box independently. The initial conditions are arbitrary. The user defines the initial and boundary conditions as well as the thermal and physical properties of the problem. Additionally, several parameters of the numerical method, e.g., degree of implicitness, time step size, are also specified by the user. DOE

**N88-11428#** Oak Ridge National Lab., Tenn.
**A COLLECTION OF TEST PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATION SOLVERS WHICH HAVE PROVISIONS FOR ROOTFINDING**
S. Thompson Aug. 1987 30 p
(Contract DE-AC05-84OR-21400)
(DE88-000045; ORNL/TM-9912) Avail: NTIS HC A03/MF A01

Several popular ordinary differential equation (ODE) solvers contain provisions for locating roots of functions which depend on the solution of the ODE. A collection of problems for testing such solvers is described in this report. In addition to several well-known problems, the collection contains other interesting problems which have not previously appeared in the literature. DOE

**N88-11429*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**THE SPATIALLY NONUNIFORM CONVERGENCE OF THE NUMERICAL SOLUTION OF FLOWS**
Argyris G. Panaras Nov. 1987 30 p
(NASA-TM-100037; A-88016; NAS 1.15:100037) Avail: NTIS HC A03/MF A01 CSCL 12A

The spatial distribution of the numerical disturbances that are generated during the numerical solution of a flow is examined. It is shown that the distribution of the disturbances is not uniform. In regions where the structure of a flow is simple, the magnitude

of the generated disturbances is small and their decay is fast. However, in complex flow regions, as in separation and vortical areas, large magnitude disturbances appear and their decay may be very slow. The observed nonuniformity of the numerical disturbances makes possible the reduction of the calculation time by application of what may be called the partial-grid calculation technique, in which a major part of the calculation procedure is applied in selective subregions, where the velocity disturbances are large, and not within the whole grid. This technique is expected to prove beneficial in large-scale calculations such as the flow about complete aircraft configurations at high angle of attack. Also, it has been shown that if the Navier-Stokes equations are written in a generalized coordinate system, then in regions in which the grid is fine, such as near solid boundaries, the norms become infinitesimally small, because in these regions the Jacobian has very large values. Thus, the norms, unless they are unscaled by the Jacobians, reflect only the changes that happen at the outer boundaries of the computation domain, where the value of the Jacobian approaches unity, and not in the whole flow field. Author

**N88-11430#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**EXTRACTION AND EVALUATION OF BOOLEAN RELATIONS FOR THE SOLUTION OF LINEAR PROGRAMS IN 0-1 VARIABLES, VOLUME 1 Ph.D. Thesis [EXTRACTION ET UTILISATION DES RELATIONS BOOLEENNES POUR LA RESOLUTION DES PROGRAMMES LINEAIRES EN VARIABLES 0-1, VOLUME 1]**
Brigitte Jaumard Jul. 1986 255 p In FRENCH
(ENST-86E023-Vol-1; ISSN-0751-1353; ETN-87-90907) Avail: NTIS HC A12/MF A01

Procedures for the solution of Boolean quadratic equations, an algorithm to combine the binary relations to deduce a logical construction, a demonstration of the pertinence of the utilization of logic relations in the reduction techniques applicable to linear programs, and an evaluation of the performance of the local heuristics to solve the problem of maximum satisfaction are described. The presented solutions are a contribution to the development of tools to solve the problem of coherence of the cognitive bases of expert systems and of data bases. ESA

**N88-11431#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**EXTRACTION AND EVALUATION OF BOOLEAN RELATIONS FOR THE SOLUTION OF LINEAR PROGRAMS IN 0-1 VARIABLES, VOLUME 2 Ph.D. Thesis [EXTRACTION ET UTILISATION DES RELATIONS BOOLEENNES POUR LA RESOLUTION DES PROGRAMMES LINEAIRES EN VARIABLES 0-1, VOLUME 2]**
Brigitte Jaumard Jul. 1986 300 p In FRENCH
(ENST-86E023-Vol-2; ISSN-0751-1353; ETN-87-90908) Avail: NTIS HC A13/MF A01

Procedures for the solution of Boolean quadratic equations, an algorithm to combine the binary relations to deduce a logical construction, a demonstration of the pertinence of the utilization of logic relations in the reduction techniques applicable to linear programs, and an evaluation of the performance of the local heuristics to solve the problem of maximum satisfaction are described. The presented solutions are a contribution to the development of tools to solve the problem of coherence of the cognitive bases of expert systems and of data bases. ESA

**N88-11432#** Lanchester Polytechnic, Coventry (England). Dept. of Mathematics.
**THE GEOMETRY OF THE KARNAUGH MAP**
R. J. Low May 1987 8 p
(ETN-87-90961) Avail: NTIS HC A02/MF A01

The Karnaugh map technique of simplifying Boolean expressions is examined; for a function in n variables this involves the study of the geometry of the unit cube in n dimensions, and the subcubes of this cube. It is shown that to simplify an expression in n variables, of the order of 3 to the nth power comparison operations are required if this method is used. ESA

**N88-11433*#** Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
**A LINEAR QUADRATIC GAUSSIAN WITH LOOP TRANSFER RECOVERY PROXIMITY OPERATIONS AUTOPILOT FOR SPACECRAFT M.S. Thesis - MIT**
George T. Chen Sep. 1987 180 p
(Contract NAS9-17560)
(NASA-CR-172028; NAS 1.26:172028; UPN-906; CSDL-T-968)
Avail: NTIS HC A09/MF A01 CSCL 12A

An automatic control scheme for spacecraft proximity operations is presented. The controller is capable of holding the vehicle at a prescribed location relative to a target, or maneuvering it to a different relative position using straight line-of-sight translations. The autopilot uses a feedforward loop to initiate and terminate maneuvers, and for operations at nonequilibrium set-points. A multivariate feedback loop facilitates precise position and velocity control in the presence of sensor noise. The feedback loop is formulated using the Linear Quadratic Gaussian (LQG) with Loop Transfer Recovery (LTR) design procedure. Linear models of spacecraft dynamics, adapted from Clohessey-Wiltshire Equations, are augmented and loop shaping techniques are applied to design a target feedback loop. The loop transfer recovery procedure is used to recover the frequency domain properties of the target feedback loop. The resulting compensator is integrated into an autopilot which is tested in a high fidelity Space Shuttle Simulator. The autopilot performance is evaluated for a variety of proximity operations tasks envisioned for future Shuttle flights. Author

**N88-11434*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**STABILITY OF SEMIDISCRETE APPROXIMATIONS FOR HYPERBOLIC INITIAL-BOUNDARY-VALUE PROBLEMS: AN EIGENVALUE ANALYSIS**
Robert F. Warming and Richard M. Beam Sep. 1986 10 p
(NASA-TM-88328; A-86318; NAS 1.15:88328) Avail: NTIS HC A02/MF A01 CSCL 12A

A hyperbolic initial-boundary-value problem can be approximated by a system of ordinary differential equations (ODEs) by replacing the spatial derivatives by finite-difference approximations. The resulting system of ODEs is called a semidiscrete approximation. A complication is the fact that more boundary conditions are required for the spatially discrete approximation than are specified for the partial differential equation. Consequently, additional numerical boundary conditions are required and improper treatment of these additional conditions can lead to instability. For a linear initial-boundary-value problem (IBVP) with homogeneous analytical boundary conditions, the semidiscrete approximation results in a system of ODEs of the form du/dt = Au whose solution can be written as u(t) = exp(At)u(O). Lax-Richtmyer stability requires that the matrix norm of exp(At) be uniformly bounded for O less than or = t less than or = T independent of the spatial mesh size. Although the classical Lax-Richtmyer stability definition involves a conventional vector norm, there is no known algebraic test for the uniform boundedness of the matrix norm of exp(At) for hyperbolic IBVPs. An alternative but more complicated stability definition is used in the theory developed by Gustafsson, Kreiss, and Sundstrom (GKS). The two methods are compared. Author

**N88-11435*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**APPROACH TRAJECTORY PLANNING SYSTEM FOR MAXIMUM CONCEALMENT**
David N. Warner, Jr. Jul. 1986 17 p
(NASA-TM-88258; A-86264; NAS 1.15:88258) Avail: NTIS HC A03/MF A01 CSCL 12A

A computer-simulation study was undertaken to investigate a maximum concealment guidance technique (pop-up maneuver), which military aircraft may use to capture a glide path from masked, low-altitude flight typical of terrain following/terrain avoidance flight

enroute. The guidance system applied to this problem is the Fuel Conservative Guidance System. Previous studies using this system have concentrated on the saving of fuel in basically conventional land and ship-based operations. Because this system is based on energy-management concepts, it also has direct application to the pop-up approach which exploits aircraft performance. Although the algorithm was initially designed to reduce fuel consumption, the commanded deceleration is at its upper limit during the pop-up and, therefore, is a good approximation of a minimum-time solution. Using the model of a powered-lift aircraft, the results of the study demonstrated that guidance commands generated by the system are well within the capability of an automatic flight-control system. Results for several initial approach conditions are presented.

Author

# 65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

**N88-11436#** Lawrence Livermore National Lab., Calif.

**RANDOM NUMBER: A SYNTAX-DIRECTED PACKAGE TO PRODUCE RANDOM NUMBERS IN USER-SPECIFIED, UNIVARIATE DISTRIBUTIONS. USER'S GUIDE**

T. H. Einwohner and A. B. Shiflet 1987 16 p Prepared in cooperation with Lander Coll., Greenwood, S.C.

(Contract W-7405-eng-48)

(DE87-014278; UCID-21132) Avail: NTIS HC A03/MF A01

Statistical simulations are an important tool in scientific work. They yield solutions to problems unobtainable by other means. Moreover, where alternative solutions are possible, statistical simulations often provide greater precision for the same computer cost. A statistical simulation requires the drawing of unbiased random numbers. And this simulation is made more efficient if unbiased. Independent random numbers can be drawn from a preassigned distribution. Provided here is an easy-to-use computer program for drawing random numbers from a user-specified, univariate distribution. The user can specify the distribution by giving its algebraic form; conversion to a language like FORTRAN is unnecessary. Another motivation for this work is to develop a syntax-directed, expert system. This package is the first part of an expert system of Monte-Carlo techniques which will in turn become part of an extensive, artificial intelligence expert system hierarchy. This package will draw random numbers from any non-negative function with finite integral over its stated domain. It will decide from a syntactic analysis whether to use special tricks or general methods. The general method used is the Rejection Method.

DOE

**N88-11437#** Sandia National Labs., Albuquerque, N. Mex.

**COMPONENTS AND CYCLES OF A RANDOM FUNCTION**

J. M. DeLaurentis 1987 12 p Presented at Crypto '87, Santa Barbara, Calif., 16 Aug. 1987

(Contract DE-AC04-76DP-00789)

(DE87-014155; SAND-87-1941C; CONF-870833-3) Avail: NTIS HC A02/MF A01

This investigation examines the average distribution of the components and cycles of a random function. Here we refer to the mappings from a finite set of, say, n elements into itself; denoted by GAMMA sub n. Suppose the elements of GAMMA sub n are assigned equal probability, i.e., P(gamma) = n(sub -n), gamma epsilon upsilon (sub n). The directed graph that is naturally associated with gamma consists of several components, each with a unique cycle. Define X sub n (s,t)(gamma) as the number of components in gamma containing at least the fraction s of the total number of nodes, with the size of each component's cycle not exceeding tn(sup 1/2). We derive an integral expression for the expected value of X sub n (s,t). The average number of components of a given size with cycles of a specified length approximately equals the volume under the graph of the integrand. This expression can be used to estimate the probability that a cycling experiment will detect a small cycle.

DOE

**N88-11438#** Oak Ridge National Lab., Tenn. Mathematical Sciences Section.

**AN EMPIRICAL INVESTIGATION OF THE USE OF RANKS IN pips SAMPLING**

Tommy Wright 1987 4 p Presented at the 46th Session of the International Statistical Inst., Tokyo, Japan, 8-16 Sep. 1987

(Contract DE-AC05-84OR-21400)

(DE87-010609; CONF-870984-1-Summ) Avail: NTIS HC A02/MF A01

Let U1,U2,...,U(sub N) be the N units of a finite population and let (y(sub i),x(sub i)) be a vector of nonnegative components associated with the i(sup th) unit, where the x's are known and the y's are unknown. A sample of fixed size n(is greater than N) is to be selected to estimate the unknown population total Y = summation of n terms (1 = 1) y(sub i). Let pi(sub i) be the probability of sample inclusion for the i(sup th) unit. Many (e.g., Hansen and Hurwitz, 1943, and Brewer and Hanif, 1983) have realized improvements in efficiency by taking pi(sub i) = np(sub i) where p(sub i) = x(sub i) summation of N terms (j = 1) x(sub j) is a normed measure of size for the i(sup th) unit. Such plans, called probability proportional to size (ps) sampling plans, can be difficult to execute when sampling is without replacement (wor), particularly when n is greater than 2. When a suitable variable x, which is directly proportional to the variable of interest y, is not available, one may know how to rank units reasonably well relative to the unknown y values before sample selection. When such ranking is possible, we introduce a simple and efficient (pi)pswor sampling plan for general n using the ranks as the known x measures of size.

DOE

**N88-11439#** Oak Ridge National Lab., Tenn.

**MEASURES OF DIVERSITY BASED ON FUZZY MULTINOMIAL DISTRIBUTIONS**

V. R. R. Uppuluri and T. N. Bhargava (Kent State Univ., Ohio.) 1987 3 p Presented at the 46th Session of the International Statistical Inst., Tokyo, Japan, 8 Sep. 1987 Prepared in cooperation with Kent State Univ., Ohio

(Contract DE-AC05-84OR-21400)

(DE87-010617; CONF-870984-2) Avail: NTIS HC A02

In this paper a fuzzy multinomial distribution is defined. Based on this, the entropy and a quadratic measure of diversity of a multinomial distribution are defined. These are illustrated by a numerical example, and problems for further study are indicated.

DOE

**N88-11440#** Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Informatique.

**METHODOLOGY OF PERFORMANCE EVALUATION OF REAL TIME DISTRIBUTED SYSTEMS [METHODOLOGIE D'EVALUATION DES PERFORMANCES DES SYSTEMES REPARTIS EN TEMPS REEL]**

Claude DutheilletLamonthezie and Alexandre Zenie Jun. 1987 107 p In FRENCH

(ENST-87D003; ISSN-0751-1345; ETN-87-90909) Avail: NTIS HC A06/MF A01

Colored stochastic Petri nets are used to evaluate the performance of distributed systems. Algorithms inspired by classical methods are employed. The CS-PN computer program was used to develop the algorithms. The program allows the validation and evaluation of the performance of the models by means of the Petri nets. The treatment is limited to Markov processes with exponential timing of transitions. The examples given include a distributed data base system and a multiprocessor architecture model.

ESA

# 66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

**N88-11441#** Forschungsinstitut der Deutschen Bundespost, Darmstadt (West Germany).
**ON THE EXACT SOLUTION OF LARGE-SCALE SIMPLE PLANT LOCATION PROBLEMS**
Manfred Koerkel May 1987 32 p
(FI-032-TB-22e; ETN-87-90791) Copyright Avail: NTIS HC A03/MF A01

The selection of facility sites from a set of possible locations with the intention of serving a given set of customers from the chosen locations is considered. The objective is to minimize the sum of the fixed charges for establishing the facilities and the transportation costs corresponding to the supply of the demands. This model may, e.g., be applied to locate Earth stations of a satellite communication system with minimum cost. It is shown how to modify a primal-dual version of Erlenkotter's exact algorithm to get an improved procedure. Computational experience with large-scale problems indicates that, compared with Erlenkotter's code, an implementation of the modified algorithm is faster by more than an order of magnitude. ESA

# 67 THEORETICAL MATHEMATICS

Includes topology and number theory.

**N88-11442#** Lawrence Livermore National Lab., Calif.
**BIMOND3: MONOTONE PIECEWISE BICUBIC HERMITE INTERPOLATION CODE**
F. N. Fritsch and R. E. Carlson Aug. 1987 42 p
(Contract W-7405-eng-48)
(DE87-014612; UCID-21143) Avail: NTIS HC A03/MF A01

BIMOND3 is a FORTRAN program for interpolating bivariate data given on a rectangular mesh. The functional form is piecewise bicubic Hermite (PBH) on the data mesh. Subroutine PBHMD determines the Hermite derivatives so that the monotonicity of the interpolant matches that of the data. There is optional user control over boundary derivatives. Subroutine PBHEV evaluates a PBH function at an arbitrary point. It is used to evaluate the interpolant on a user-specific plotting mesh. DOE

**N88-11443#** Lawrence Livermore National Lab., Calif.
**A SHAPE PRESERVING INTERPOLANT WHICH HAS TENSION CONTROLS**
T. A. Foley May 1987 37 p
(Contract W-7405-eng-48)
(DE87-014615; UCID-21155) Avail: NTIS HC A03

The monotonicly and convexly constrained (MONCON) weighted v-spline interpolant, which preserves local monotonicity and local convexity of the data, is presented. The MONCON weighted v-spline is the $C^1$ piecewise cubic, whose partition is defined by the data, which minimizes a variational problem subject to monotonicity and convexity constraints. The minimized variational function is the same as that minimized by the weighted v-spline, which is a generalization of the $C^2$ cubic spline, the weighted spline and the v-spline. By minimizing the constrained variational problem, the user not only generates a shape preserving interpolant, but the user can also interactively modify the shape of the curve using tension parameters and still preserve local monotonicity and convexity. An aspect of the work presented here that can apply to other methods is the definition of piecewise monotonicity constraints that vary continuously with respect to the data. DOE

**N88-11444#** California Univ., Berkeley. Lawrence Berkeley Lab.
**ANOMALIES IN GAUGE THEORIES Ph.D. Thesis**
Dae Sung Hwang Mar. 1987 56 p
(Contract DE-AC03-76SF-00098)
(DE87-014087; LBL-23440; UCB-PTH-87/20) Avail: NTIS HC A04

In a situation where a symmetry at the classical level is not a symmetry at the quantum level, the amount by which an effective action violates the symmetry, if it cannot be removed by adding a local functional to the effective action, is called an anomaly. Various topics of anomalies in two dimensions are studied. Topics covered include the anomalies of Yang-Mills gauge theory, gravitational theory, and supersymmetric gauge theory. The solution of the anomaly equation (the Wess-Zumino term) is obtained with only gauge fields, without auxiliary fields. A method is found to obtain the anomaly of the chiral current from the Schwinger terms of the equal time commutation relations. In the study of gravitational anomaly, Feynman diagrams are calculated to get an effective action, and it is shown, up to the second non-trivial order, that this effective action is in agreement with the anomaly obtained by the differential geometric method. A supersymmetric extension of the gauge anomaly is obtained, and it is shown that this is the origin of a supersymmetry anomaly in the Wess-Zumino gauge. DOE

**N88-11445#** Argonne National Lab., Ill. Mathematics and Computer Science Div.
**REDUCE-AIDED STUDY OF A PROBLEM IN HERMITIAN MATRIX THEORY**
Man Kam Kwong Jul. 1987 28 p
(Contract W-31109-eng-38)
(DE87-014331; ANL-87-31) Avail: NTIS HC A03/MF A01

Let A be any n x n positive definite matrix and B any n x n non-negative definite matrix. In an earlier paper we showed that for each n there is a real number t sub n greater than 2 such that if t less than t sub n then the solution X of the matrix equation $A^3X + XA^3 + tAXA = B$ is non-negative definite. For $n = 2$, t sub 2 = infinity and for $n = 3$, t sub $3 = 8$. In this report we show that t sub $4 = 4$, t sub 5 less than 3.02048507 and t sub 6 less than 2.62120330. DOE

**N88-11446#** Texas Univ., Austin. Center for Particle Theory.
**INEQUIVALENT QUANTIZATIONS AND FUNDAMENTALLY PERFECT SPACES**
T. D. Imbo and E. C. G. Sudarshan Jun. 1987 11 p
(Contract DE-FG05-85ER-40200)
(DE87-014225; DOE/ER-40200/102) Avail: NTIS HC A03/MF A01

We investigate the problem of inequivalent quantizations of a physical system with multiply connected configuration space X. For scalar quantum theory on X we show that state vectors must be single-valued if and only if the first homology group H sub 1 (X) is trivial, or equivalently the fundamental group pi sub 1 (X) is perfect. The theta-structure of quantum gauge and gravitational theories is discussed in light of this result. DOE

**N88-11447#** Japan Atomic Energy Research Inst., Tokyo.
**STRUCTURE-DEPENDENT MATRIX REPRESENTATION OF MANIPULATOR KINEMATICS AND ITS INVERSE SOLUTION**
Shinobu Sasaki Mar. 1987 31 p In JAPANESE; ENGLISH summary
(DE87-752966; JAERI-M-87-039) Avail: NTIS (US Sales Only) HC A03/MF A01

In this paper, derivation of kinematic equations for a six-link manipulator is presented using the homogeneous transformation (A sub i-matrix) based on Denavit-Hartenberg method, and additionally a solution procedure of its inverse problem is outlined. In order to examine the validity of a system of equations, solutions were compared with the exact ones of the inverse kinematics (for the same type of a manipulator) expressed in arbitrarily given co-ordinate systems. Through complete agreement of joint solutions between the two, the present purpose was accomplished. As shown in this paper, an explicit description between adjacent links will give a possible clue to a systematic treatment of the inverse problem for a class of manipulators. DOE

**N88-11448#** Hiroshima Univ. (Japan). Research Inst. for Theoretical Physics.
**COVARIANT LORENTZ ANOMALIES IN HIGHER DIMENSIONAL SPACE**
Satoshi Yajima and Toshiei Kimura Feb. 1987 35 p
(DE87-753021; RRK-87-2) Avail: NTIS (US Sales Only) HC A03/MF A01

The covariant Lorentz anomalies are evaluated by both the path integral and the topological methods, when Weyl fermions couple with the gauge and gravitational fields. In 2,4,6-dimensional curved space, the difference between the results obtained by the two methods is removed by counterterms and the equivalence of both methods is proved. It is shown that the Lorentz anomalies in flat space of arbitrary dimensions are eliminated. DOE

# 70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**N88-11449#** Sandia National Labs., Albuquerque, N. Mex.
**A TUTORIAL ON ROGOWSKI COIL THEORY AND OPERATION**
C. R. McClenahan Aug. 1987 35 p
(Contract DE-AC04-76DP-00789)
(DE88-000006; SAND-87-0043) Avail: NTIS HC A03/MF A01

Without rigorously deriving the equations describing Rogowski coils, this memorandum describes how Rogowski coils work and why a Rogowski coil detects the charge passing through its toroidal opening yet remains insensitive to the details of the charge distribution. Rogowski coils sense the time derivative of the current (dI/dt), and produce a proportional output. Nevertheless, an experimenter usually wants to measure the current. Often, a passive integrator used with a Rogowski coil can provide an output signal proportional to the current passing through the toroidal opening in the coil. To illustrate the use of Rogowski coils and integrators, the equation for calculating the sensitivity of a Rogowski coil is derived, and calculated and measured sensitivities of an actual Rogowski coil compared. The calculated sensitivity of 84 +/- 13 mV-ms/kA agrees well with the measured sensitivity of 81 +/- 2 mV-ms/kA. The integrator constructed for and used with the Rogowski coil described here has a measured time constant of 102 +/-4 ms. Therefore, to determine the current passing through the toroidal opening in the Rogowski coil, the voltage at the output of the integrator is multiplied by 1.26 +/- 0.06 kA/mV. DOE

# 71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

**N88-11450*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**EVALUATION OF A SCALE-MODEL EXPERIMENT TO INVESTIGATE LONG-RANGE ACOUSTIC PROPAGATION**
Tony L. Parrott, Gerry L. McAninch, and Ingrid A. Carlberg Nov. 1987 55 p
(NASA-TP-2748; L-16300; NAS 1.60:2748) Avail: NTIS HC A04/MF A01 CSCL 20A

Tests were conducted to evaluate the feasibility of using a scale-model experiment situated in an anechoic facility to investigate long-range sound propagation over ground terrain. For a nominal scale factor of 100:1, attenuations along a linear array of six microphones colinear with a continuous-wave type of sound source were measured over a wavelength range from 10 to 160 for a nominal test frequency of 10 kHz. Most tests were made for a hard model surface (plywood), but limited tests were also made for a soft model surface (plywood with felt). For grazing-incidence propagation over the hard surface, measured and predicted attenuation trends were consistent for microphone locations out to between 40 and 80 wavelengths. Beyond 80 wavelengths, significant variability was observed that was caused by disturbances in the propagation medium. Also, there was evidence of extraneous propagation-path contributions to data irregularities at more remote microphones. Sensitivity studies for the hard-surface and microphone indicated a 2.5 dB change in the relative excess attenuation for a systematic error in source and microphone elevations on the order of 1 mm. For the soft-surface model, no comparable sensitivity was found. Author

**N88-11451*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**HELICOPTER MAIN-ROTOR SPEED EFFECTS ON FAR-FIELD ACOUSTIC LEVELS**
Arnold W. Mueller, Otis S. Childress, and Mark Hardesty (McDonnell-Douglas Helicopter Co., Mesa, Ariz.) Oct. 1987 20 p Prepared for presentation at the 114th Meeting of the Acoustical Society of America, Miami, Fla., 16-20 Nov. 1987
(NASA-TM-100512; NAS 1.15:100512) Avail: NTIS HC A03/MF A01 CSCL 20A

The design of a helicopter is based on an understanding of many parameters and their interactions. For example, in the design stage of a helicopter, the weight, engine, and rotor speed must be considered along with the rotor geometry when considering helicopter operations. However, the relationship between the noise radiated from the helicopter and these parameters is not well understood, with only limited model and full-scale test data to study. In general, these data have shown that reduced rotor speeds result in reduced far-field noise levels. This paper reviews the status of a recent helicopter noise research project designed to provide experimental flight data to be used to better understand helicopter rotor-speed effects on far-field acoustic levels. Preliminary results are presented relative to tests conducted with a McDonnell Douglas model 500E helicopter operating with the rotor speed as the control variable over the range of 103% of the main-rotor speed (NR) to 75% NR, and with the forward speed maintained at a constant value of 80 knots. Author

**N88-11452#** National Bureau of Standards, Gaithersburg, Md.
**PRECISION METROLOGY COMPARING ULTRASONIC AND OTHER TECHNIQUES FOR THE DETERMINATION OF STEEL THICKNESS**
G. V. Blessing, D. G. Eitzen, A. V. Clark, Jr., and R. E. Schramm (National Bureau of Standards, Boulder, Colo.) Jun. 1987 27 p Presented at the Review of Progress in Quantitative NDE, Williamsburg, Va., 21 Jun. 1987 Prepared in cooperation with National Bureau of Standards, Boulder, Colo.
(Contract DE-AC04-76DP-03533)
(DE87-011051; RFP-4121; CONF-870691-2) Avail: NTIS HC A03

The accurate in-situ measurement of part dimensions during fabrication is of much interest to the manufacturing industry, especially for untended manufacturing. The goal of this work is to apply noncontacting ultrasonic techniques to the precise thickness measurement, during machining, of parts of rotation possessing a nominal wall thickness of 1.5 mm. The required accuracy is + or - 2.5 microns at all points on the approximately 250 mm diameter steel shell. The approach is to precisely measure ultrasonic echo transit times, and calculate part dimensions from an accurate knowledge of the material sound speed. To that end, feasibility results on flat disk specimens possessing a wide range of grain sizes have been obtained. Both longitudinal (10 to 30 MHz) and shear (3 MHz) wave measurements were made, the latter using electromagnetic acoustic transducers. Comparisons were made of the calculated ultrasonic values with precision interferometer dimensional measurements, revealing a significant dependence of ultrasonic accuracy on sample grain size. Satisfactory agreement was observed for all grain sizes using longitudinal waves, but only for the finer grain specimens using shear waves. The resulting dominance of grain size in limiting ultrasonic accuracy, especially for shear waves, was evaluated in light of a model treating the samples as random aggregates of cubic crystals. DOE

**N88-11453#** Oak Ridge National Lab., Tenn.
**PLASMON RESONANCE ABSORPTION IN LAYERED STRUCTURES OF SILVER WITH PERIODIC CORRUGATION**
E. T. Arakawa, T. Inagaki, and J. P. Goudonnet 1987 5 p Presented at the 31st SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16 Aug. 1987
(Contract DE-AC05-84OR-21400)
(DE87-013183; CONF-8708110-3) Avail: NTIS HC A02/MF A01

Plasmon resonance absorption in periodically corrugated layered structures of silver was studied by the photoacoustic method. The layered structures were self-supporting and corrugated with a period of 1888 nm and amplitude varying from 6 to 12 nm, depending on the thickness. Experimental results of resonance absorption of 633-nm photons were analyzed in terms of the propagation and damping constants of coupled modes of surface plasmons. The coupling efficiency of incident photons to these modes was found to be strongly dependent on corrugation amplitude and layer thickness. DOE

**N88-11454#** Institut Franco-Allemand de Recherches, St. Louis (France).
**EXPERIMENTAL STUDY OF THE PROPAGATION OF AN ACOUSTIC WAVE IN THE LOW ATMOSPHERE [ETUDE EXPERIMENTALE DE LA PROPAGATION D'UNE ONDE ACOUSTIQUE DANS LA BASSE ATMOSPHERE]**
G. Parmentier, J. Vermorel, E. Burde, and P. Gnemmi 6 May 1986 54 p In FRENCH
(Contract DRET-85-053)
(ISL-R-111/86; ETN-87-90636) Avail: NTIS HC A04/MF A01

A 104 dB acoustic source was used for the transmission of acoustic waves at frequencies between 63 Hz and 4 kHz. Microphones were installed along a 1 km length wavepath to study the propagation and to calculate atmospheric attenuation as a function of meteorological parameters. The results highlight problems related to the experimental study of acoustic atmospheric propagation. The importance of meteorological parameters is confirmed. The results are not sufficient to attempt to establish correlations. ESA

**N88-10864*#** Rockwell International Corp., Canoga Park, Calif.
**DESIGN, CONSTRUCTION, ACTIVATION, AND OPERATION OF A HIGH INTENSITY ACOUSTIC TEST CHAMBER Abstract Only**
L. T. Kamel *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 414 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20A

**N88-10865*#** Orincon Corp., La Jolla, Calif.
**A DIGITAL CONTROL SYSTEM FOR HIGH LEVEL ACOUSTIC NOISE GENERATION**
John P. Lee and Jerry H. Bosco (Lockheed Missiles and Space Co., Sunnyvale, Calif.) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 415-426 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20A

# 72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

**N88-11455#** Stanford Linear Accelerator Center, Calif.
**AN INTRODUCTION TO CHARM AND HEAVY QUARK PHYSICS**
F. J. Gilman Jun. 1987 46 p Presented at the Charm Physics Symposium, Beijing, China, 4 Jun. 1987
(Contract DE-AC03-76SF-00515)
(DE87-013589; SLAC-PUB-4352; CONF-8706185-1) Avail: NTIS HC A03

The physics of the electroweak and strong interactions in the standard model are reviewed, especially as they apply to the tau lepton and to charm and heavy quark physics. DOE

**N88-11456#** California Univ., Berkeley. Lawrence Berkeley Lab.
**CURRENT EXPERIMENTS IN ELEMENTARY PARTICLE PHYSICS**
Mar. 1987 166 p
(Contract DE-AC03-76SF-00098)
(DE87-013961; LBL-91-Rev) Avail: NTIS HC A08

This report contains summaries of 720 recent and current experiments in elementary particle physics (experiments that finished taking data before 1980 are excluded). Included are experiments at Brookhaven, CERN, CESR, DESY, Fermilab, Moscow Institute of Theoretical and Experimental Physics, Tokyo Institute of Nuclear Studies, KEK, LAMPF, Leningrad Nuclear Physics Institute, Saclay, Serpukhov, SIN, SLAC, and TRIUMF, and also experiments on proton decay. Instructions are given for searching online the computer database (maintained under the SLAC/SPIRES system) that contains the summaries. Properties of the fixed-target beams at most of the laboratories are summarized. DOE

**N88-11457#** Argonne National Lab., Ill.
**PROCEEDINGS OF THE WORKSHOP ON OPPORTUNITIES FOR ATOMIC PHYSICS USING SLOW, HIGHLY-CHARGED IONS**
1987 298 p Workshop held in Argonne, Ill., 12 Jan. 1987
(Contract W-31-109-eng-38)
(DE87-013991; ANL-PHY-87-1; CONF-870152) Avail: NTIS HC A13/MF A01

The study of atomic physics with highly-charged ions is an area of intense activity at the present time because of a convergence of theoretical interest and advances in experimental techniques. The purpose of the Argonne Workshop on Opportunities for Atomic Physics Using Slow, Highly-Charged Ions was to bring together atomic, nuclear, and accelerator physicists in order to identify what new facilities would be most useful for the atomic physics community. The program included discussion of existing once-through machines, advanced ion sources, recoil ion techniques, ion traps, and cooler rings. One of the topics of the Workshop was to discuss possible improvement to the ANL Tandem-Linac facility (ATLAS) to enhance the capability for slowing down ions after they are stripped to a high-charge state (the Accel/Decel technique). Another topic was the opportunity for atomic physics provided by the ECR ion source which is being built for the Uranium Upgrade of ATLAS. Eighteen analytics were prepared for the individual papers in this volume. DOE

**N88-11458#** Rochester Univ., N. Y. Dept. of Physics and Astronomy.
**THEORETICAL ATOMIC AND MOLECULAR PHOTOPHYSICS Final Report, 1 Oct. 1983 - 30 Sep. 1986**
J. H. Eberly Aug. 1987 17 p Prepared in cooperation with LLNL, Calif.
(Contract W-7405-eng-48)
(DE87-014249; UCRL-15932) Avail: NTIS HC A03/MF A01

The results of a theoretical study of long-path stimulated Raman scattering and amplified spontaneous emission in an idealized atomic absorber, under coherent transient conditions and allowing for collisional and Doppler broadening effects are reported. DOE

**N88-11459#** Vanderbilt Univ., Nashville, Tenn. Dept. of Physics and Astronomy.
**EXPERIMENTAL NUCLEAR PHYSICS Progress Report, Sep. 1986 - Jul. 1987**
J. H. Hamilton Aug. 1987 30 p
(Contract DE-AS05-76ER-05034)
(DE87-014586; DOE/ER-05034/10) Avail: NTIS HC A03/MF A01

The research activities of the experimental nuclear structure group at Vanderbilt University carried out under Contract AS05-76ER05034 with the Department of Energy for the period September 1986 to July 1987 are reported here. Research continues in the areas of: (1) in-beam A-ray spectroscopy including cooperations with scientists at Oak Ridge, Univ. of Rochester, Univ. of Koeln, Louisiana State Univ., Univ. of Florida, Idaho Falls, and Univ. of Notre Dame; (2) studies of nuclei far from stability at UNISOR and at the recoil mass spectrometer at the University of Rochester; (3) nucleon transfer reaction and fusion-fission studies with scientists at ORNL, Argonne National Laboratory, Univ. of Michigan, and University of Kansas; (4) theoretical studies with scientists at Univ. Frankfurt, Univ. Tuebingen, Univ. Lund, Brookhaven, Lawrence Berkeley, and ORNL; (5) other studies. In general, abstracts of papers published or submitted for publication in this period make up this report along with brief reports of work in process and complete copies of a few conference papers. DOE

**N88-11460#** Virginia Univ., Charlottesville. Dept. of Physics.
**ELECTRON INTERACTIONS WITH NUCLEI Progress Report**
J. S. McCarthy Aug. 1987 82 p
(Contract DE-FG05-86ER-40261)
(DE87-014587; DOE/ER-40261/2) Avail: NTIS HC A05/MF A01

High energy research is being conducted at the Stanford Linear Accelerator Center. This includes inclusive electron scattering, electroexcitation of the delta in nuclei, longitudinal and transverse response in the quasi-elastic region, the $q^4$ dependence of $^4He(e,e p)$, deep inelastic scattering from nuclei, transverse and longitudinal response in the resonance region, nuclear physics at PEP and 1.6 GeV spectrometer properties. Additional high energy research on electron scattering on $^3H$ and $^3He$ and the nuclear structure of $^{205}Tl$ and $^{208}Pb$ are being conducted at MIT-Bates. Other activities are being carried out at Saclay and research and development for Monte Carlo studies of Hall A spectrometers for CEBAF is being conducted. DOE

**N88-11461#** International Centre for Theoretical Physics, Trieste (Italy).
**QUANTUM ELECTRODYNAMICS BASED ON SELF-ENERGY: SPONTANEOUS EMISSION IN CAVITIES**
A. O. Barut and J. P. Dowling Oct. 1986 15 p
(DE87-703071; IC-86/330) Avail: NTIS (US Sales Only) HC A03/MF A01

We extend a previously developed formulation of quantum electrodynamics (QED) based on self-energy to include the effect of perfectly conducting boundaries on spontaneous emission. The method is quite general and applicable to any quantum system and many boundary geometries. In particular, we compute the spontaneous emission rate of an atom near a conducting plate, inside a spherical cavity and between parallel plates, we give general formulas and predict both enhanced and inhibited rates, in agreement with recent experiments. DOE

**N88-11462#** Brookhaven National Lab., Upton, N. Y.
**RELATIVISITIC HEAVY ION COLLISIONS**
M. J. Tannenbaum 1987 22 p Presented at the CEBAF Summer Workshop, Newport News, Va., 22 Jun. 1987
(Contract DE-AC02-76CH-00016)
(DE87-014292; BNL-40066; CONF-8706200-2) Avail: NTIS HC A03/MF A01

Some of the objectives and observables of Relativistic Heavy Ion Physics are presented. The first experimental results from oxygen interactions at CERN, 200 GeV/c per nucleon, and BNL, 14.5 GeV/c per nucleon are shown. The data indicate more energy emission than was originally predicted. DOE

**N88-11463#** Lawrence Livermore National Lab., Calif.
**ELECTRON CAPTURE FROM SOLIDS BY POSITRONS**
R. Howell Aug. 1987 9 p Presented at the 4th International Workshop on Positrons in Gases, London, United Kingdom, 16 Jul. 1987
(Contract W-7405-eng-48)
(DE87-014355; UCRL-97264; CONF-870731-1) Avail: NTIS HC A02/MF A01

The capture of electrons in solids is modified from that in gases by several factors. The most important is the collective interaction of the electrons which results in a density of electron states in the solid in wide bands. Also the high density of electrons in many solids gives a high frequency of interaction as compared to gases, and quickly destroys any electron-positron states in the metal matrix. Consequently, most positrons implanted in a metal will rapidly thermalize, and unless they reach the surface will annihilate with an electron in an uncorrelated state. Positronium formation from positrons scattered at a metal surface is analogous to ion neutralization however, most of the positronium comes from positrons passing through the surface from the bulk. The dominant motivation for studying positronium formation has been the hope that the distribution of the electrons at the surface would be obtained through the annihilation properties of positrons trapped at the surface or through analysis of the energy and angular distributions of the positronium emitted into the vacuum. These distributions have been measured and are included in this paper. DOE

**N88-11464#** Washington Univ., Seattle. Dept. of Electrical Engineering.
**NUCLEAR MAGNETIC RESONANCE STUDIES OF ION MOTION IN SOLID ELECTROLYTES Final Report**
John L. Bjorkstam 26 Aug. 1987 3 p
(Contract DE-FG06-84ER-45065)
(DE87-014547; DOE/ER-45065/1) Avail: NTIS HC A02/MF A01

This report presents a brief review of work carried out in connection with superionic conductors, especially sodium-beta-alumina. The spin-lattice relaxation time was measured. DOE

**N88-11465#** California Univ., Berkeley. Lawrence Berkeley Lab.
**SYSTEMATIC STUDIES OF MOLECULAR VIBRATIONAL ANHARMONICITY AND VIBRATION-ROTATION INTERACTION BY SELF-CONSISTENT-FIELD HIGHER DERIVATIVE METHODS: APPLICATIONS TO ASYMMETRIC AND SYMMETRIC TOP AND LINEAR POLYATOMIC MOLECULES Ph.D. Thesis**
D. A. Clabo, Jr. Apr. 1987 195 p
(Contract DE-AC03-76SF-00098)
(DE87-014691; LBL-23710) Avail: NTIS HC A09/MF A01

Inclusion of the anharmonicity normal mode vibrations (i.e., the third and fourth (and higher) derivatives of a molecular Born-Oppenheimer potential energy surface) is necessary in order to theoretically reproduce experimental fundamental vibrational frequencies of a molecule. Although ab initio determinations of harmonic vibrational frequencies may give errors of only a few percent by the inclusion of electron correlation within a large basis set for small molecules, in general, molecular fundamental vibrational frequencies are more often available from high resolution vibration-rotation spectra. Recently developed analytic third derivative methods for self-consistent-field (SCF) wavefunctions have made it possible to examine with previously unavailable accuracy and computational efficiency the anharmonic force fields of small molecules. DOE

**N88-11466#** Los Alamos National Lab., N. Mex.
**A NEUTRON DETECTOR BASED ON MICROCHANNEL PLATES**
D. W. MacArthur Jun. 1987 8 p
(Contract W-7405-eng-36)
(DE87-014703; LA-11039-MS) Avail: NTIS HC A02/MF A01

We propose a large-area neutron detector design based on microchannel plates (MCPs). Two characteristics of the MCP make it ideal as a high-rate neutron detector: (1) its signals can have a very fast rise time, and (2) it can count at a high rate. The MCP-based detector could use both the high-voltage power supplies and the readout electronics designed for a neutron

detector based on the multiwire proportional chamber (MWPC).
DOE

**N88-11467#** Japan Atomic Energy Research Inst., Tokyo.
**CALCULATION METHODS OF ATOMIC NUMBER DENSITY FOR VARIOUS NUCLEAR MATERIALS**
Yuichi Komuro, Tomohiro Sakai, and Shou-ichi Nakamaru Mar. 1987 52 p In JAPANESE; ENGLISH summary
(DE87-753006; JAERI-M-87-037) Avail: NTIS (US Sales Only) HC A04/MF A01

Microscopic cross sections for criticality calculations are calculated by summarizing products of microscopic cross sections and atomic number densities of each nuclide contained in the region. This calculation, indeed, is not so difficult, but the results are slightly different due to some differences of data used such as atomic weight, Avogadro number, theoretical fuel density. Then, atomic number density calculation equations based on experimental data and reliable physical constants were collected, and theoretical equations for calculating atomic number density were derived in this report. AND - a program for calculation of atomic number density were made based on these equations and data. Users of the program can easily get atomic number densities of various nuclear materials with high reliability. DOE

**N88-11468#** Texas Univ., Austin. Center for Particle Theory.
**RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY Progress Report, 1 Jan. - Dec. 1987**
E. C. G. Sudarshan and D. A. Dicus Aug. 1987 89 p
(Contract DE-FG05-85ER-40200)
(DE88-000159; DOE/ER-40200/114) Avail: NTIS HC A05/MF A01

Progress is reported in the areas of: strings and gauge theories, mathematical physics and quantum optics, high energy physics phenomenology, quantum chromodynamic sum rules, and application of particle physics to astrophysics. Titles of DOE reports resulting from this research are listed, and the research histories of the scientific staff of the Center for Particle Theory are given.
DOE

**N88-11469#** British Library Lending Div., Boston Spa (England).
**THEORY OF INTERSTITIAL SOLUTIONS**
A. P. Beloglazov and A. A. Zhukhovitskii 1987 13 p Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy Chernaya Metallurgiya (USSR), no. 1, 1987 p 95-100
(BLL-M-37314-(5828.4)) Avail: British Library Lending Div., Boston Spa, United Kingdom

The partial enthalpy and activity of a component of an interstitial solution are examined. For this, a simplified model is used taking into account the penetrating movement of interstitial atoms and their oscillation in the interstices. Experimental data relating to the concentration dependence of the activity of carbon in austenite are used to calculate the proportion of forward moving particles.
Author

**N88-11470*#** Midwest Research Inst., Kansas City, Mo.
**THE STUDY OF EXCITED OXYGEN MOLECULE GAS SPECIES PRODUCTION AND QUENCHING ON THERMAL PROTECTION SYSTEM MATERIALS Final Report**
Paul C. Nordine, Gordon T. Fujimoto, and Frank T. Greene 24 Jun. 1987 60 p
(Contract NAS9-17261)
(NASA-CR-172027; NAS 1.26:172027) Avail: NTIS HC A04/MF A01 CSCL 20H

The detection of excited oxygen and ozone molecules formed by surface catalyzed oxygen atom recombination and reaction was investigated by laser induced fluorescence (LIF), molecular beam mass spectrometric (MBMS), and field ionization (FI) techniques. The experiment used partially dissociated oxygen flows from a microwave discharge at pressures in the range from 60 to 400 Pa or from an inductively coupled RF discharge at atmospheric pressure. The catalyst materials investigated were nickel and the reaction cured glass coating used for Space Shuttle reusable surface insulation tiles. Nonradiative loss processes for the laser excited states makes LIF detection of O2 difficult such that formation of excited oxygen molecules could not be detected in the flow from the microwave discharge or in the gaseous products of atom loss on nickel. MBMS experiments showed that ozone was a product of heterogeneous O atom loss on nickel and tile surfaces at low temperatures and that ozone is lost on these materials at elevated temperatures. FI was separately investigated as a method by which excited oxygen molecules may be conveniently detected. Partial O2 dissociation decreases the current produced by FI of the gas. Author

**N88-10836*#** National Aeronautics and Space Administration, Washington, D.C.
**AN INVESTIGATION OF THE BEHAVIOR OF OUTGASSED MOLECULES IN THERMAL VACUUMS**
W. Mahone, R. Kays (Lockheed Engineering and Management Services Co., Inc., Las Cruces, N. Mex.), and S. Koontz *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 64-65 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20H

# 73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

**N88-11471#** Lawrence Livermore National Lab., Calif.
**GAS-COOLED REACTOR FOR SPACE POWER SYSTEMS**
C. E. Walter and J. S. Pearson May 1987 9 p Presented at the 22nd Intersociety Energy Conversion Engineering Conference, Philadelphia, Pa., 10 Aug. 1987
(Contract W-7405-eng-48)
(DE87-011549; UCRL-95973; CONF-870804-19) Avail: NTIS HC A02/MF A01

Reactor characteristics based on extensive development work on the 500 MWt reactor for the Pluto nuclear ramjet are described for space power systems useful in the range of 2 to 20 MWe for operating time of 1 yr. The modest pressure drop through the prismatic ceramic core is supported at the outlet end by a ceramic dome which also serves as a neutron reflector. Three core materials are considered which are useful at temperatures up to about 2000 K. Most of the calculations are based on a beryllium oxide with uranium dioxide core. Reactor control is accomplished by use of a burnable poison, a variable leakage reflector, and internal control rods. Reactivity swings of 20 percent are obtained with 12 internal boron-10 rods for the size cores studied. Criticality calculations were performed using the ALICE Monte Carlo code. The inherent high temperature capability of the reactor design removes the reactor as a limiting condition on system performance. The low fuel inventories required, particularly for beryllium oxide reactors, make space power systems based on gas cooled near thermal reactors a lesser safeguard risk than those based on fast reactors. DOE

**N88-11472#** Sandia National Labs., Albuquerque, N. Mex.
**SATURN: A LARGE AREA X-RAY SIMULATION ACCELERATOR**
D. D. Bloomquist, R. W. Stinnett, D. H. McDaniel, J. R. Lee, A. W. Sharpe, J. A. Halbleib, L. G. Schlitt, P. W. Spence, and P. Corcoran (Pulse Sciences, Inc., San Leandro, Calif.) 1987 9 p Presented at the 6th Institute of Electrical and Electronic Engineers Pulsed Power Conference, Arlington, Va., 29 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012021; SAND-87-0129C; CONF-870656-39) Avail: NTIS HC A02

Saturn is the result of a major metamorphosis of the Particle Beam Fusion Accelerator-I (PBFA-I) from an ICF research facility to the large-area X-ray source of the Simulation Technology

Laboratory (STL) project. Renamed Saturn, for its unique multiple-ring diode design, the facility is designed to take advantage of the numerous advances in pulsed power technology. Saturn will include significant upgrades in the energy storage and pulse-forming sections. The 36 magnetically insulated transmission lines (MITLs) that provided power flow to the ion diode of PBFA-I were replaced by a system of vertical triplate water transmission lines. These lines are connected to three horizontal triplate disks in a water convolute section. Power will flow through an insulator stack into radial MITLs that drive the three-ring diode. Saturn is designed to operate with a maximum of 750 kJ coupled to the three-ring e-beam diode with a peak power of 25 TW to provide an X-ray exposure capability of 5 x $10^{13}$ rads/s (Si) and 5 cal/g (Au) over 500 $cm^2$. DOE

**N88-11473#** Sandia National Labs., Albuquerque, N. Mex.
**THE HERMES-3 PROGRAM**
J. J. Ramirez, K. R. Prestwich, E. L. Burgess, J. P. Furaus, R. A. Hamil, D. L. Johnson, T. L. Sanford, L. O. Seamons, L. X. Schneider, and G. A. Zawadzkas 1987 6 p Presented at the 6th Inst. of Electrical and Electronic Engineers Pulsed Power Conference, Arlington, Va., 29 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012132; SAND-87-0082C; CONF-870656-37) Avail: NTIS HC A02

Hermes 3 is a new gamma ray simulator being built at Sandia National Laboratories as part of the Simulation Technology Laboratory (STL). It will deliver a 20-ns FWHM, 20-ns 10% to 90% rise time, radiation pulse with a peak dose rate of 5 x 10 to the 12th power rad(Si)/sec over a cylindrical volume with a 500-sq cm front surface area and 15 cm long. The radiation pulse will be uniform within a factor of two across the front surface and within a factor of four anywhere within the volume. The minimum dose rate will be 2.5 x 10 to the 12th power rad(Si)/sec within this volume. The overall configuration of the Hermes-3 accelerator is presented together with a discussion of the requirements for the individual components. A brief summary of the subsystems performance obtained to date is also presented. DOE

**N88-11474#** Stanford Linear Accelerator Center, Calif.
**THE NATURE OF BEAMSTRAHLUNG**
Pisin Chen Apr. 1987 10 p Presented at the Workshop on Physics at Future Accelerators, La Thuile, Italy, 7-10 Jan. 1987
(Contract DE-AC03-76SF-00515)
(DE87-012837; SLAC-PUB-4293; CONF-870180-1-Summ) Avail: NTIS HC A02/MF A01

The physical nature of beamstrahlung during beam-beam interaction in linear colliders is reviewed. The distinction is first made between a dense beam and a dilute beam. The characteristics of synchrotron radiation (SR) and bremsstrahlung are then reviewed, and it is argued that for a wide range of beam parameters beamstrahlung is SR in nature, even if the beam is dilute. Some issues concerning the specific conditions in beamstrahlung as SR are then discussed. Finally, it is suggested that in order to suppress beamstrahlung energy loss and to improve energy resolution, it is desirable to partition a bunch into a train of bunchlets, where the length of each bunchlet is shorter than the SR convergence length. DOE

**N88-11475#** Stanford Linear Accelerator Center, Calif.
**A CONCEPTUAL DESIGN OF FINAL FOCUS SYSTEMS FOR LINEAR COLLIDERS**
Karl L. Brown Jun. 1987 8 p Presented at the 2d Joint US/CERN School on Particle Accelerators: Frontiers of Particle Beams, South Padre Island, Tex., 23-29 Oct. 1986
(Contract DE-AC03-76SF-00515)
(DE87-012840; SLAC-PUB-4159; CONF-8610108-3; CONF-870170-3) Avail: NTIS HC A02/MF A01

Linear colliders are a relatively recent development in the evolution of particle accelerators. This report discusses some of the approaches that have been considered for the design of Final Focus Systems to demagnify the beam exiting from a linac to the small size suitable for collisions at the interaction point. The system receiving the most attention is the one adopted for the SLAC Linear Collider. However, the theory and optical techniques discussed should be applicable to the design efforts for future machines. DOE

**N88-11476#** Brookhaven National Lab., Upton, N. Y. National Synchrotron Light Source.
**INTERACTIVE DESIGN OF ACCELERATORS (IDA)**
Mark Q. Barton 30 Jun. 1987 18 p
(Contract DE-AC02-76CH-00016)
(DE87-013298; BNL-40011) Avail: NTIS HC A03/MF A01

IDA is a beam transport line calculation program which runs interactively on an IBM PC computer. It can be used for a large fraction of the usual calculations done for beam transport systems or periods of accelerators or storage rings. Because of the interactive screen editor nature of the data input, this program permits one to rather quickly arrive at general properties of a beam line or an accelerator period. DOE

**N88-11477#** Brookhaven National Lab., Upton, N. Y. National Synchrotron Light Source.
**COMPACT ELECTRON STORAGE RINGS**
Gwyn P. Williams 1987 15 p Presented at the 5th National Synchrotron Radiation Instrumentation Conference, Madison, Wis., 21-25 Jun. 1987 Submitted for publication
(Contract DE-AC02-76CH-00016)
(DE87-013301; BNL-40055; CONF-870610-9) Avail: NTIS HC A03/MF A01

There have been many recent developments in the area of compact storage rings. Such rings would have critical wavelengths of typically 10 A, achieved with beam energies of several hundreds of MeV and superconducting dipole fields of around 5 Tesla. Although the primary motivation for progress in this area is that of commercial X-ray lithography, such sources might be an attractive source for college campuses to operate. They would be useful for many programs in materials science, solid state, X-ray microscopy and other biological areas. We discuss the properties of such sources and review developments around the world, primarily in the USA, Japan and W. Germany. DOE

**N88-11478#** Continuous Electron Beam Accelerator Facility, Newport New, Va.
**PRESENT STATUS OF THE HIGH RESOLUTION SPECTROMETERS**
J. Mougey [1987] 25 p
(CEBAF-PR-87-029) Avail: NTIS HC A03/MF A01

Although much work is still to be done, both on spectrometer optics and in design optimization of the magnetic elements, the high resolution spectrometers are gradually taking shape. The optics designs are going to be frozen by the end of September, and the main concepts for the design of the magnetic elements should be defined by the end of the year. Choice of the best scenario for out-of-plane experiments, extended target capability, and use of polarized targets will be extensively discussed during the 1987 Summer Study Meeting. B.G.

**N88-11479#** Continuous Electron Beam Accelerator Facility, Newport News, Va.
**HIGH-FREQUENCY LIMIT OF THE LONGITUDINAL IMPEDANCE**
S. A. Heifets and S. A. Kheifets (Stanford Univ., Calif.) [1987] 20 p
(CEBAF-PR-87-030) Avail: NTIS HC A03/MF A01

A method of iterations which takes into account finite widths of resonances is developed and used to calculate the longitudinal impedance for a cylindrical cavity with side pipes. In the high-frequency limit the dependence of the real part of the impedance on the frequency is omega sup -1/2 in agreement with estimates for average impedance obtained earlier. Author

**N88-11480#** Oak Ridge National Lab., Tenn.
**REVIEW OF DIFFUSION BARRIER TECHNOLOGY FOR APPLICATION IN SP-100 FUEL PINS**

M. A. Schmidt and M. J. Kania Aug. 1987 16 p
(Contract DE-AC05-84OR-21400)
(DE88-000021; ORNL/TM-10467) Avail: NTIS HC A03/MF A01

The fuel pin design for the SP-100 reactor uses uranium nitride fuel contained in a niobium alloy (Nb-1Zr) cladding. Chemical reactions occur between the fuel and the cladding at the planned operating temperatures of 1350 to 1500 K, so a diffusion barrier is required to prevent degradation. The technology associated with diffusion barriers in similar fuel pins is reviewed to identify fabrication techniques and to summarize previous results of chemical compatibility and irradiation tests. Four fabrication techniques were identified. In previous tests, diffusion barriers have performed successfully for up to 12,000 h at cladding temperatures near 1300 K. A significant challenge remains to develop and qualify a diffusion barrier for the SP-100 mission application, which has a lifetime greater than 60,000 h. DOE

# 74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

**N88-11481*#** Honeywell, Inc., Clearwater, Fla. Space and Strategic Avionics Div.
**PINHOLE OCCULTER EXPERIMENT Final Report**
Jeff Ring and John Pflug 27 Feb. 1987 141 p
(Contract NAS8-36101)
(NASA-CR-179206; NAS 1.26:179206) Avail: NTIS HC A07/MF A01 CSCL 20F

Viewgraphs and charts from a briefing summarize the accomplishments, results, conclusions, and recommendations of a feasibility study using the Pinhole Occulter Facility (POF). Accomplishments for 1986 include: (1) improved IPS Gimbal Model; (2) improved Crew Motion Disturbance Model; (3) use of existing shuttle on-orbit simulation to study the effects of orbiter attitude deadband size on POF performance; (4) increased understanding of maximum performance expected from current actuator/sensor set; (5) use of TREETOPS nonlinear time domain program to obtain system dynamics describing the complex multibody flexible structures; (6) use of HONEY-X design tool to design and evaluate multivariable compensator for stability, robustness, and performance; (7) application of state-of-the-art compensator design methodology Linear Quadratic Gaussian/Loop Transfer Recovery (LQG/LTR); and (8) examination of tolerance required on knowledge of the POF boom flexible mode frequencies to insure stability, using structure uncertainty analysis. J.P.B.

**N88-11482#** Wyoming Univ., Laramie. Dept. of Electrical Engineering.
**EFFECTS OF RADIATION DAMAGE IN OPTICAL FIBERS: A TUTORIAL**
Thad J. Englert May 1987 63 p Sponsored by National Telecommunications and Information Administration, Boudler, Colo.
(PB87-210308; NTIA-CR-87-38) Avail: NTIS HC A04/MF A01 CSCL 20F

The report discusses the physics and some measured results of the effects of radiation damage in optical fibers. Examples are illustrated and discussed. The kinds and amounts of radiation are analyzed with regard to their relation to the capacity of single-mode and multi-mode optical fibers. GRA

**N88-11483#** Sandia National Labs., Albuquerque, N. Mex.
**AN AUTONOMOUS, CLOSED-LOOP POINTING SYSTEM FOR USE WITH SATELLITE OPTICS**
Robert O. Woods 1987 7 p Presented at the 31st SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16 Apr. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012011; SAND-86-2962C; CONF-8708110-4) Avail: NTIS HC A02

The availability of microcomputer control has allowed a new design philosophy to be introduced which is of particular interest for remote or unattended instrumentation. Instead of attempting to create systems that will retain their attributes (e.g., mechanical dimensions) in the presence of all perturbations, it is now possible to use an arrangement in which errors are expected, but reduced to tolerable values by the exercise of machine intelligence. This involves sensors to monitor performance and effectors that actively reduce the error. With such a concept it is frequently possible to achieve better results with lighter and more compact hardware and to eliminate the need for human intervention to retain calibration. The presence of a microcomputer also makes it possible for a machine to perform functions that were previously left to human judgment. One of these, the resolution of seeming ambiguities, is the subject of this paper. DOE

**N88-11484#** Sandia National Labs., Albuquerque, N. Mex.
**PYROELECTRIC LINE SCANNER FOR REMOTE IR IMAGING OF VEHICLES**
C. V. Jakowatz, Jr., A. J. Smiel, and P. H. Eichel 1987 7 p Presented at the 31st SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012127; SAND-87-0382C; CONF-8708110-6) Avail: NTIS HC A02

The design and development of a small-aperture imaging system used for surveillance of vehicular traffic at night is discussed. Such a sensor may have applicability to the safeguarding of a secure facility, where it is important to monitor vehicle activity near the facility perimeter. The sensing element is a linear pyroelectric focal plane array. Motion of a target vehicle provides for scanning in the horizontal direction, and negates the need for a chopper to produce a differential IR signal. Also presented are various digital image processing procedures that are employed to enhance the collected image data, since the images produced by such an array are qualitatively quite different than those obtained in the visible portion of the spectrum. The array consists of 32 lithium tantalate (LiTaO3) elements spaced on 15 mil centers on a single crystal, with element dimensions of 13 by 32 mils. Thirty-two individual on-chip hybrid detector pre-amplifiers reduce the large switching noise that would accompany post-multiplexer amplification. Processed images collected with this prototype system are shown. DOE

**N88-11485#** Lawrence Livermore National Lab., Calif.
**RADIATION-INDUCED TRANSIENT ATTENUATION OF OPTICAL FIBERS AT 800 AND 1300 nm**
L. D. Looney and P. B. Lyons 1987 10 p Presented at the Society of Photo-Optical Instrumentation Engineers Conference, Orlando, Fla., 20-25 May 1987
(Contract W-7405-eng-36)
(DE87-013165; LA-UR-87-2465; CONF-870584-11) Avail: NTIS HC A02/MF A01

Radiation-induced absorption in optical fibers has been a subject of considerable interest. As availability and applications of fibers have evolved from first window systems operating near 850 nm to second window systems near 1300 nm, interest in wavelength dependence of radiation effects in optical fibers has similarly evolved. The present work summarizes second-window, radiation-induced transient absorption measurements in optical fibers for times shorter than 5 microsec. Comparisons to first window data for these fibers are also presented. Only high purity silica fibers with low-OH concentrations were used in the present study to avoid the large OH absorption band in this region. This paper also collects first window data on several high-OH optical fibers. DOE

**N88-11486*#** Chicago Univ., Ill.
**DEVELOPMENT OF AN X-RAY FLUORESCENCE MICROPROBE AT THE NATIONAL SYNCHROTRON LIGHT SOURCE, BROOKHAVEN NATIONAL LABORATORY: EARLY RESULTS: COMPARISON WITH DATA FROM OTHER TECHNIQUES**
J. V. Smith, M. L. Rivers, S. R. Sutton, K. W. Jones, A. L. Hanson, and B. M. Gordon (Brookhaven National Lab., Upton, N. Y.) 1986 11 p Presented at the 11th International Congress on X-ray Optics and Microanalysis, London, Ontario, 4 Aug. 1986 Submitted for publication
(Grant NAG9-109)
(NASA-CR-181468; NAS 1.26:181468; DE87-013302; BNL-40053; CONF-8608121-3) Avail: NTIS HC A03/MF A01 CSCL 20F

Theoretical predictions for the detection levels in X-ray fluorescence analysis with a synchrotron storage ring are being achieved experimentally at several laboratories. This paper is deliberately restricted to the state of development of the Brookhaven National Laboratory/University of Chicago instruments. Analyses at the parts per million (ppM) level are being made using white light apertured to 20 microns and an energy dispersive system. This system is particularly useful for elements with Z is greater than 20 in materials dominated by elements with Z is less than 20. Diffraction causes an interference for crystalline materials. Development of a focusing microprobe for tunable monochromatic X-rays and a wavelength dispersive spectrometer (WDS) is delayed by problems in shaping an 8:1 focusing mirror to the required accuracy. Reconnaissance analyses with a wiggler source on the CHESS synchrotron have been made in the K spectrum up to Z = 80. DOE

**N88-11487#** Lawrence Livermore National Lab., Calif.
**DESCRIPTION OF A MULTIFRAME OPTICAL PROBING SYSTEM**
O. Willi Jul. 1987 10 p Prepared in cooperation with Willi (O.), London (England)
(Contract W-7405-eng-48)
(DE87-014255; UCRL-15930) Avail: NTIS HC A02/MF A01

A multiframe optical probing system is briefly described. This system allows several images separated in time to be taken on each laser shot. Consequently, it is extremely attractive for investigations of the temporal behavior of the plasma blow-off. DOE

**N88-11488#** Chicago Univ., Ill.
**FUNDAMENTALS AND TECHNIQUES OF NONIMAGING OPTICS RESEARCH Final Report**
R. Winston and J. OGallagher 1987 21 p
(Contract DE-FG02-84ER-13178)
(DE87-014544; DOE/ER-13178/T1) Avail: NTIS HC A03/MF A01

Nonimaging Optics differs from conventional approaches in its relaxation of unnecessary constraints on energy transport imposed by the traditional methods for optimizing image formation and its use of more broadly based analytical techniques such as phase space representations of energy flow, radiative transfer analysis, thermodynamic arguments, etc. Based on these means, techniques for designing optical elements which approach and in some cases attain the maximum concentration permitted by the Second Law of Thermodynamics were developed. The most widely known of these devices are the family of Compound Parabolic Concentrators (CPC's) and their variants and the so called Flow-Line or trumpet concentrator derived from the geometric vector flux formalism developed under this program. Applications of these and other such ideal or near-ideal devices permits increases of typically a factor of four (though in some cases as much as an order of magnitude) in the concentration above that possible with conventional means. Present efforts can be classed into two main areas: (1) classical geometrical nonimaging optics, and (2) logical extensions of nonimaging concepts to the physical optics domain. DOE

**N88-11489#** Texas Univ., Austin. Center for Particle Theory.
**FAMILIES OF BOSE RAYS IN QUANTUM OPTICS**
N. Mukunda, E. C. G. Sudarshan, and R. Simon (Institute of Mathematical Science, Madras, India ) Jul. 1987 23 p
(Contract DE-FG05-85ER-40200)
(DE87-014584; DOE/ER-40200/108) Avail: NTIS HC A03/MF A01

Having known classical wave optics and wave mechanics, is it possible to reverse Schroedinger's path and extend the concept of families of rays of light to provide a new exact rendering of quantum optics including the Bose nature of photons. This question is answered in the affirmative, and the implications of the Bose symmetry for certain nonlocal correlations of the many ray distribution functions are worked out. The similarities and the differences between classical and quantum wave optics are brought out. The ray-ray Bose correlation is analyzed. The generating functional for the many ray distribution functions is formulated; and the notion of paraxial illumination for quantum optics is made precise. DOE

**N88-11490#** Rochester Univ., N. Y. Dept. of Chemistry.
**DIRECT INFRARED ABSORPTION OF CLUSTERS IN PULSED MOLECULAR BEAMS Progress Report No. 1, 1 May 1986 - 31 Jul. 1987**
J. S. Muenter 1987 7 p
(Contract DE-FG02-87ER-60514)
(DE87-014802; DOE/ER-60514/1) Avail: NTIS HC A02/MF A01

This report describes accomplishments over the past year in research supported by this grant, and also outlines plans for the next year. The principal goal for future work is the continued development of a new molecular beam infrared absorption spectrometer, and the application of this instrument to the study of cluster molecules of atmospheric importance. Current results presented here document the present capabilities of this program. This report also describes the completion of previous work on excited vibrational states of stable molecules. Several reprints of journal articles are enclosed. DOE

**N88-11491#** Loughborough Univ. of Technology (England).
**THE DESIGN AND CONSTRUCTION OF A THERMALLY CONTROLLED SINGLE MODE FIBER SWITCH M.S. Thesis**
S. A. Ayres 1987 72 p
(ETN-87-90929) Avail: NTIS HC A04/MF A01

A thermally controlled switch for a single mode optical fiber was developed. Access to the guided light in the fiber is obtained by grinding and polishing away the fiber cladding enabling interaction to take place between the evanescent field of the guided light and an oil, the refractive index of which can be changed thermally. An analysis of the construction of the device, including the photolithographically deposited heating electrodes is presented, and experimental data covering the intensity, phase, and coupling response of the device at various frequencies is given. ESA

**N88-10861*#** Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
**SCENE SIMULATION FOR PASSIVE IR SYSTEMS**
J. D. Holt, R. Dawbarn, and A. B. Bailey (Calspan Field Services, Inc., Arnold AFS, Tenn.) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 367-382 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 20F

## 75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

**N88-11492#** Lawrence Livermore National Lab., Calif. National Magnetic Fusion Energy Computer Center.
**COMPUTER MODELS FOR KINETIC EQUATIONS OF MAGNETICALLY CONFINED PLASMAS**

J. Killeen, G. D. Kerbel, M. G. McCoy, A. A. Mirin, E. J. Horowitz, and D. E. Shumaker 1987 29 p Presented at the International Conference on Plasma Physics, Kiev, USSR, 6-12 Apr. 1987
(Contract W-7405-eng-48)
(DE87-011571; UCRL-96829; CONF-8704170-1) Avail: NTIS HC A03/MF A01

This paper presents four working computer models developed by the computational physics group of the National Magnetic Fusion Energy Computer Center. All of the models employ a kinetic description of plasma species. Three of the models are collisional, i.e., they include the solution of the Fokker-Planck equation in velocity space. The fourth model is collisionless and treats the plasma ions by a fully three-dimensional particle-in-cell method. DOE

**N88-11493#** Oak Ridge National Lab., Tenn. Physics Div.
**HEAVY-PARTICLE COLLISIONS IN THE PLASMA EDGE**
R. A. Phaneuf, H. T. Hunter, and C. F. Barnett Jul. 1987 18 p Presented at the Meeting on Atomic and Molecular Data for Plasma Edge Studies, Vienna, Austria, 8-10 Jul. 1987
(Contract DE-AC05-84OR-21400)
(DE87-012928; CONF-870788-1-Summ) Avail: NTIS HC A03/MF A01

Available cross-section data for heavy-particle collision processes which play important roles in the edge plasma of magnetically-confined fusion devices are surveyed and reviewed. The species considered include H, H2, He, C, O, Fe, and their ions. The most important heavy-particle collision processes occurring in the edge plasma are charge-exchange reactions. Excitation and dissociation processes are also considered. Emphasis is given to relative collision velocities corresponding to plasma ion temperatures in the 1 to 200 eV range. Evaluated or recommended data are presented where possible along with their estimated uncertainties, and gaps in the data base are indicated. DOE

**N88-11494#** California Univ., Berkeley. Electronics Research Lab.
**A RELATIVISTIC MONTE CARLO BINARY COLLISION MODEL FOR USE IN PLASMA PARTICLE SIMULATION CODES**
R. J. Procassini, C. K. Birdsall, E. C. Morse, and B. I. Cohen (Lawrence Livermore National Lab., Calif.) 14 May 1987 39 p
(Contract DE-FG03-86ER-53220)
(DE87-013287; UCB/ERL-M-87/24) Avail: NTIS HC A03/MF A01

Particle simulations of plasma physics phenomena employ far fewer particles than the systems being simulated, owing to the limited speed and memory capacity of even the most powerful supercomputers. If the simulation consists of point particles in a gridless domain, then the combination of the small number of particles in a Debye sphere and the possibility of zero-impact parameters, large-angle scattering results in a significant enhancement of fluctuation phenomena such as collisions. Collisional processes in a simulation may be difficult because of disparate time scales. A comparison of the relevant physical time scales of the system being simulated usually yields a large range of values. For instance, the grid-cell transit time is usually several orders of magnitude smaller than the 90 deg scattering time. Much of the physical phenomena of interest in the simulation are due to these long-time-scale collisional processes, but short-time-scale processes (such as particle bounce times in a mirror or tokamak) must be adequately resolved if the plasma dielectric response and the plasma potential are to be accurately determined. The binary collision mode within the electrostatic code and the results of computer simulations of velocity space transport are discussed. Also discussed are the timing statistics for the collision package relative to the other major physics packages in the code, as well as recommendations on the frequency of use of the collision package within the simulation sequence. DOE

**N88-11495#** Lawrence Livermore National Lab., Calif.
**USE OF POLARIMETRY TO MEASURE THE CURRENT PROFILE IN MTX**
W. M. Nevins, E. B. Hooper, and I. B. Bernstein 14 Jul. 1987 23 p Prepared in cooperation with Yale Univ., New Haven, Conn.
(Contract W-7405-eng-48)
(DE87-013835; UCID-21123) Avail: NTIS HC A03/MF A01

It is possible in principle to measure the poloidal magnetic field profile, and hence, the profile of the plasma current measuring the change in the polarization of a sequence of microwave beams that pass through the plasma. Actual measurements of the plasma current profile would be very interesting in connection with Lower-Hybrid (or EC) current drive experiments since this would provide direct information on modification of the current profile by the application of RF power. A microwave polarimetry diagnostic on MTX as part of the microwave interferometer is being considered. This diagnostic would be constructed in collaboration with Neville Luhmann and Tony Peebles at UCLA. The diagnostic would utilize the multicord far-infrared interferometer which is designed to operate at a base wavelength of 0.185 mm. This paper reviews the understanding of the physics issues raised by this diagnostic, concurring with Luhmann and Peebles' conclusion that the polarimetry measurements would be easier at longer wavelengths. An increase of only a factor of 2 in the wavelength would make a substantial difference since the signal to be measured goes as lambda$^4$. Hence, in this paper operation at longer wavelengths (0.337 mm and 0.447 mm) in addition to operation at 0.119 and 0.185 mm will be considered. DOE

**N88-11496#** California Univ., Berkeley. Coll. of Engineering.
**COMPACT TORUS STUDIES Final Report**
E. C. Morse Jun. 1987 37 p Prepared in cooperation with Lawrence Livermore National Lab., Calif.
(Contract W-7405-eng-48)
(DE87-014254; UCRL-15918) Avail: NTIS HC A03/MF A01

The compact torus (CT) device has been proposed for use in some applications which are of interest in Laboratory programs in the areas of pulsed power and inertial confinement fusion. These applications involve compression and acceleration of CT plasmas. The RACE (Ring Accelerator Experiment) experimental program at Livermore has been initiated to study these applications. The work reported here involves studies of plasma physics and other aspects of these compact torus applications. The studies conducted identify specific problem areas associated with the CT device and examine these areas in some detail. This report contains studies of three particular problem areas of the CT applications. These three areas are: the general nonlinear properties of the CT as a magnetohydrodynamic (MHD) equilibrium, particle simulation of the compression of the CT, with a focus on the non-MHD effects, and nonlinear RF interaction problems in the CT. DOE

**N88-11497#** Sandia National Labs., Albuquerque, N. Mex.
**EFFECT OF COLLISIONAL BROADENING ON THE POLARIZABILITY OF A TWO-DIMENSIONAL ELECTRON GAS**
S. K. Lyo 17 Aug. 1987 7 p Presented at the 3rd International Conference on Superlattices, Microstructures and Microdevices, Chicago, Ill., 17 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-013928; SAND-87-2016C; CONF-8708112-2) Avail: NTIS HC A02/MF A01

The effect of collisional damping (GAMMA) of electronic levels on the Lindhard polarizability is studied for a degenerate two-dimensional electron gas interacting with ionized impurities using an effective mass approximation. A specific wave-vector dependence as well as the GAMMA-dependence of the correction to the polarizability is obtained. The consequence of this result on the low-temperature mobility is discussed. DOE

**N88-11498#** Avco-Everett Research Lab., Mass.
**MHD (MAGNETOHYDRODYNAMICS) CHANNEL DEVELOPMENT Quarterly Report, Oct. - Dec. 1986**
Jan. 1987 139 p
(Contract DE-AC22-84PC-70507)
(DE87-014126; DOE/PC-70507/11) Avail: NTIS HC A07/MF A01

Both Faraday and diagonal loaded MHD generators have larger power outputs at high wall temperatures for all generator sizes investigated. The increase in power at high T(sub w) diminishes with generator scale due to the drop in heat losses per unit volume as channels scale up. Boundary layer electrical detriments are volumetric effects and thus are not too different when scaled to larger MHD generators. Voltage drops and axial shorting effects dominate at low wall temperature while velocity defects become important at high wall temperature. An experiment to investigate the effects of cathode resegmentation on the performance of an MHD generator controlled the cathode resegmentation effect by using externally shorted cathodes and by minimizing internal shorting by eliminating the ash injection. The data obtained from this experiment provide insights into the current flow within the shorted regions. The data also provides a qualitative understanding of the effect of cathode resegmentation on the internal electric fields and current densities. Review of the 86-SEED-6 test results indicates that a significant portion of the 1A channel power shortfall is associated with loss of Hall voltage. The Hall voltage loss may be coupled to axial current leakage in the slag layer as demonstrated during the post-power conductivity measurement test. The results of oil-fired and the coal-fired generator tests from the CDIF are compared. The axial leakage effects are much more dominant in the latter. This shortfall is the result of the increased leakage. DOE

**N88-11499#** Texas Univ., Austin. Inst. for Fusion Studies.
**THERMALLY DRIVEN CONVECTIVE CELLS AND TOKAMAK EDGE TURBULENCE**
D. R. Thayer and P. H. Diamond Jul. 1987 44 p
(Contract DE-FG05-80ET-53088)
(DE87-014424; DOE/ET-53088/292; IFSR-292) Avail: NTIS HC A03/MF A01

A unified theory for the dynamics of thermally driven convective cell turbulence is presented. The cells are excited by the combined effects of radiative cooling and resistivity gradient drive. The model also includes impurity dynamics. Parallel thermal and impurity flows enhanced by turbulent radial duffusion regulate and saturate overlapping cells, even in regimes dominated by thermal instability. Transport coefficients and fluctuation levels characteristic of the saturated turbulence are calculated. It is found that the impurity radiation increases transport coefficients for high density plasmas, while the parallel conduction damping, elevated by radial diffusion, in turn quenches the thermal instability. The enhancement due to radiative cooling provides a resolution to the dilemma of explaining the experimental observation that potential fluctuations exceed density fluctuations in the edge plasma (e PHI T sub e greater than n/n0). DOE

**N88-11500#** Texas Univ., Austin. Inst. for Fusion Studies.
**NEW DIRECTIONS IN VLASOV PLASMA TURBULENCE AND ANOMALOUS TRANSPORT**
P. W. Terry, P. H. Diamond, and T. S. Hahm Jul. 1987 26 p Presented at the International Conference on Plasma Physics, Kiev, (USSR), 6 Apr. 1987
(Contract DE-FG05-80ET-53088)
(DE87-014425; DOE/ET-53088/293; CONF-8704170-2; IFSR-293) Avail: NTIS HC A03/MF A01

The nature and role of nonwavelike incoherent fluctuations in Vlasov plasma turbulence and transport are considered. In particular, electrostatic drift holes, which are localized, self-binding incoherent fluctuations giving large negative skewness, are described in detail. Both the three dimensional structure and dynamics of drift holes are discussed. The important role of incoherent fluctuations in plasma transport is underscored with an example, that of transport in drift-Alfven turbulence. DOE

**N88-11501#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**ENHANCED NOISE AND RAMAN SCATTERING IN PLASMA**
A. Simon and R. W. Short Apr. 1987 9 p Presented at the International Conference on Plasma Physics, Kiev (USSR), 6 Apr. 1987
(Contract DE-FC08-85DP-40200)
(DE87-014466; DOE/DP-40200/53; CONF-8704170-3) Avail: NTIS HC A02/MF A01

Observations of Raman scattering from laser-produced plasma have shown a number of puzzling features. These can be explained by assuming the presence of a bump-on-tail electron distribution created by pulses of fast electrons arising from instabilities at the critical (n sub c) or the quarter-critical (n sub c 4) surface. Experiments using thin foils, in which the target density drops below n sub c and even n sub c 4 early in the laser pulse, have continued to show the same agreement as is seen for thick targets between the observed Raman spectrum and the predictions of this theory. This raises the issue of the time scale on which such directed pulses of fast electrons can continue to exist in the plasma after their source at n sub c or n sub c 4 disappears. We show that the classical degradation process is quite slow (of the order of 100 ps or more). Collective processes would appear to broaden and flatten the beam on a faster time scale. However, inclusion of finite spatial size strongly reduces the effect. Furthermore, we will show that broadening of the beam has little effect on the predicted spectrum. DOE

**N88-11502#** International Centre for Theoretical Physics, Trieste (Italy).
**STUDY OF IONIZATION EQUILIBRIUM OF HIGH TEMPERATURE AND LOW DENSITY PLASMA**
B. Alam Dec. 1986 32 p
(DE87-703070; IC-86/327) Avail: NTIS (US Sales Only) HC A03/MF A01

The works on ionization equilibrium available in the literature are briefly reviewed. Fractional ion abundance of coronal ions of C, N, O, Ne, Mg, Al, Si, S, Ca and Fe are calculated by using a new formula for the rate coefficient of dielectric recombination given by Alam and Ansari (1985). On comparison it is found that our results for highly charged ions are nearly in agreement with those of others. But for ions of low ionization stages our results differ substantially. DOE

**N88-11503#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**ENHANCED THOMSON SCATTERING FROM LASER PLASMAS**
S. H. Batha, W. Seka, L. M. Goldman, A. Simon, R. W. Short, R. Bahr, and W. Lockman 1986 13 p Presented at the American Physical Society Plasma Physics Division Meeting, Baltimore, Md., 3 Nov. 1986
(Contract DE-FC08-85DP-40200)
(DE87-014463; DOE/DP-40200/39; CONF-861110-8) Avail: NTIS HC A03/MF A01

Carried out is a preliminary series of experiments to investigate the origin of broad band features in the scattered light spectrum of laser-produced plasmas. Results are consistent with the Thomson Scattering model enhanced by the presence of a non-thermal electron distribution as opposed to the usual convective stimulated Raman scattering model. DOE

**N88-11504#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**TIME-RESOLVED TEMPERATURE AND DENSITY MEASUREMENTS IN IONIZING, UNIFORMLY IRRADIATED UV-LASER-PRODUCED PLASMAS**
R. Marjoribanks, P. Audebert, L. DaSilva, J. Delettrez, R. Epstein, G. Gregory, P. Jaanimagi, and M. Richardson 1986 14 p Presented at the American Physical Society Plasma Physics Division Meeting, Baltimore, Md., 3-7 Nov. 1986
(Contract DE-FC08-85DP-40200)
(DE87-014649; DOE/DP-40200/41; CONF-861110-9-Vugraphs) Avail: NTIS HC A03

The purpose of these experiments is to produce a well-defined measurement of local temperature and density in an X-ray emitting region of a uniformly irradiated UV-laser-produced plasma. Results are given the viewgraphs that make up the report. DOE

**N88-11505#** Cornell Univ., Ithaca, N.Y.
**FIELD-REVERSING ELECTRON AND ION RINGS FOR THE CONFINEMENT AND HEATING OF PLASMAS Annual Progress Report, 1 Sep. 1986 - 31 Aug. 1987**

H. H. Fleischmann 1 Sep. 1987 5 p
(DE-AC02-76ET-53017)
(DE87-014669; DOE/ET-53017/81) Avail: NTIS HC A02/MF A01

This paper updates experiments being done on the confinement and heating of plasma at Cornell University. Such experiments discussed are: megavolt ion coil experiment, the MERGE experiment on the merging of plasma and electron rings, precessional stabilization of rings in resistive walls, and theoretical investigation on ion-ring equilibria. DOE

**N88-11506#** Los Alamos National Lab., N. Mex.
**X-RAY EMISSION FROM HIGH-Z SPHERICAL LASER PLASMAS: IMPLICATIONS FOR PLASMA DYNAMICS**
P. D. Goldstone, J. A. Cobble, A. Hauer, G. Stradling, W. C. Mead, S. R. Goldman, S. Coggeshall, M. C. Richardson, P. A. Jaanimagi, and O. Barnouin 1987 18 p Presented at the 31st SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16 Aug. 1987 Prepared in cooperation with Rochester Univ., N.Y.
(Contract W-7405-eng-36)
(DE87-014722; LA-UR-87-2746; CONF-8708110-9) Avail: NTIS HC A03/MF A01

Conversion of 351-nm laser light to soft X-rays has been studied using spherical gold targets irradiated at 5 x 10 to the 12th power - 4 x 10 to the 15th power W/sq cm. Spectra and time histories of sub-keV and M-band emission are presented. Results have been compared to detailed models (LASNEX) to better determine the dynamics of the plasma processes which lead to X-ray emission. DOE

**N88-11507#** Texas Univ., Austin. Inst. for Fusion Studies.
**ON TOKAMAK EQUILIBRIUM**
R. D. Hazeltine and M. H. Montgomery Aug. 1987 21 p
(Contract DE-FG05-80ET-53088)
(DE87-014811; DOE/ET-53088/297; IFSR-297) Avail: NTIS HC A03/MF A01

Large aspect-ratio tokamak equilibrium is studied, including effects, such as ellipticity of the flux surfaces, of second order in the inverse aspect ratio. To facilitate the interpretation of experimental data, the analysis uses simple coordinates that are readily evaluated, rather than coordinates based on the exact flux surfaces. An explicit formula for the safety factor, including second order terms, is presented, along with a brief discussion of rotational effects. DOE

**N88-11508#** Oak Ridge National Lab., Tenn. Fusion Engineering Design Center.
**SYSTEM STUDIES OF COMPACT IGNITION TOKAMAKS**
J. D. Galambos, D. T. Blackfield, Y. K. M. Peng, R. L. Reid, D. J. Strickler, and E. Selcow Aug. 1987 75 p
(Contract DE-AC05-84OR-21400)
(DE87-014976; ORNL/FEDC-86/5) Avail: NTIS HC A04/MF A01

The new Tokamak Systems Code, used to investigate Compact Ignition Tokamaks (CITs), can simultaneously vary many parameters, satisfy many constraints, and minimize or maximize a figure of merit. It is useful in comparing different CIT design configurations over wide regions of parameter space and determining a desired design point for more detailed physics and engineering analysis, as well as for performing sensitivity studies. Operational windows in major radius (R) and toroidal field (B) space for fixed ignition margin are calculated for the Ignifed and Inconel candidate CITs. The minimum R bounds are predominantly physics limited, and the maximum R portions of the windows are engineering limited. For a modified Kaye-Goldston plasma-energy confinement scaling, the minimum size is 1.15 m for Ignifed and 1.25 m for Inconel. With the Ignition Technical Oversight Committee (ITOC) physics guidance of $B^3a/q$ and I(sub p) greater than 10 MA, the Ignifed and Base-line Inconel devices have a minimum size of 1.2 and 1.25 m and a toroidal field of 11 and 10.4 T, respectively. Sensitivity studies show Ignifed more sensitive to coil temperature changes, and the Inconel device is more sensitive to stress perturbations. DOE

**N88-11509#** Japan Atomic Energy Research Inst., Tokyo.
**IMPROVEMENT OF ENERGY CONFINEMENT OF NEUTRAL BEAM HEATED PLASMA BY LOWER HYBRID CURRENT DRIVE IN JT-60**
Kenkichi Ushigusa, Takeshi Imai, and Ryuji Yoshino Feb. 1987 26 p
(DE87-752983; JAERI-M-87-012) Avail: NTIS (US Sales Only) HC A03/MF A01

Energy and particle confinements in a high power neutral beam heated plasma are improved by a lower hybrid current drive (LHCD) in JT-60. A clear correlation between the improvement of the energy confinement time and the decrease of the plasma internal inductance caused by LHCD is observed. The energy confinement time of the profile-controlled plasma by LHCD is close to the ohmic confinement time and does not degrade with the beam absorption power up to 11 MW. DOE

**N88-11510#** Japan Atomic Energy Research Inst., Tokyo.
**TWO DIMENSIONAL NEUTRAL TRANSPORT ANALYSIS IN TOKAMAK PLASMA**
Katsuhiro Shimizu and Masafumi Azumi Feb. 1987 32 p In JAPANESE; ENGLISH summary
(DE87-752984; JAERI-M-87-028) Avail: NTIS (US Sales Only) HC A03/MF A01

Neutral particle influences the particle and energy balance, and play an important role on sputtering impurity and the charge exchange loss of neutral beam injection. In order to study neutral particle behavior including the effects of asymmetric source and divertor configuration, the two dimensional neutral transport code has been developed using the Monte-Carlo techniques. This code includes the calculation of the H sub alpha radiation intensity based on the collisional-radiation model. The particle confinement time of the Joule heated plasma in JT-60 tokamak is evaluated by comparing the calculated H sub alpha radiation intensity with the experimental data. The effect of the equilibrium on the neutral density profile in high-beta plasma is also investigated. DOE

**N88-11511#** Japan Atomic Energy Research Inst., Tokyo.
**TRANSPORT ANALYSIS OF OH AND NBI HEATED DISCHARGES IN JT-60**
Toshio Hirayama, Katsuhiro Shimizu, and Mitsuru Kikuchi Mar. 1987 35 p
(DE87-752985; JAERI-M-87-029) Avail: NTIS (US Sales Only) HC A03/MF A01

Transport properties of ohmically and NBI heated plasmas in JT-60 have been analyzed by using the one-dimensional tokamak transport code. The very flat density profiles observed in ohmic heating discharges are explained by no inward flow velocity of hydrogen. The saturation of the energy confinement time at high density discharges is due to the increase of the ion energy loss channel and the combination of the neoclassical ion heat diffusivity X(sub i)(sup CH) with multiplication factor of around 6 and the electron heat diffusivity X(sub e) = 5 x 10 to the 19th power/cu m well reproduces experimental data in the density range of n-bar(sub e) = (2 to approximate 8) x 10 to the 19th power/cu m. The analysis also shows that the electrical conductivity has the Spitzer-type dependence and the trapped electron correction is small. The degradation of the energy confinement under the high power NBI heating is due to the enhancement of electron heat diffusivity. For discharges with 20 MW NBI heating, electron heat diffusivity increases to X(sub e) = 5 sq m/s at n-bar(sub e) = 5 x 10 to the 19th power/cu m. By taking into account the beam pressure, it was also shown that stored energies evaluated by the magnetic analysis is consistent with the value evaluated from the transport analysis. DOE

**N88-11512#** Japan Atomic Energy Research Inst., Tokyo.
**TECHNICAL EVALUATION OF MAJOR CANDIDATE BLANKET SYSTEMS FOR FUSION POWER REACTOR**
Tatsuzo Tone, Masahiro Seki, and Akio Minato Mar. 1987 749

p In JAPANESE; ENGLISH summary
(DE87-752989; JAERI-M-87-017) Avail: NTIS (US Sales Only)
HC A99/MF A01

The key functions required for tritium breeding blankets for a fusion power reactor are ; (1) self-sufficient tritium breeding, (2) in-situ tritium recovery and low tritium inventory, (3) high temperature cooling giving a high efficiency of electricity generation and (4) thermo-mechanical reliability and simplified remote maintenance to obtain high plant availability. Blanket performance is substantially governed by materials selection. Major options of structure/breeder/coolant/neutron multiplier materials considered for the present design study are PCA/Li/sub 2/O/H/sub 2/O/Be, Mo-alloy/Li/sub 2/O/He/Be, Mo-alloy/LiAlO/sub 2//He/Be, V-alloy/Li/Li/none, and Mo-alloy/Li/He/none. In addition, remote maintenance of blankets, tritium recovery system, heat transport and energy conversion have been investigated. In this report, technological problems and critical R and D issues for power reactor blanket development are identified and a comparison of major candidate blanket concepts is discussed in terms of the present materials data base, economic performance, prospects for future improvements, and engineering feasibility and difficulties based on the results obtained from individual design studies. improvements, and engineering feasibility and difficulties based on the results obtained from individual design studies. DOE

**N88-11513#** Japan Atomic Energy Research Inst., Tokyo.
**SPECTROGRAMS OF THE VISIBLE REGION IN THE JT-60 TOKAMAK (WAVELENGTH RANGE FROM 2210 A TO 5250 A)**
Nobuo Akaoka, Hirotaka Kubo, Tatsuo Sugie, Akira Sakasai, and Yoshihiko Koide Mar. 1987 24 p In JAPANESE; ENGLISH summary
(DE87-753002; JAERI-M-87-054) Avail: NTIS (US Sales Only)
HC A03/MF A01

In order to obtain the basically spectroscopic data for the investigation of impurity behavior in JT-60 tokamak, the spectrographic measurement of the visible spectral lines in ohmically heated plasma were performed by 0.5 m Czerny-Turner type spectrometer which covered the wave length range from 2210 A to 5250 A. The low ionized spectral lines of oxygen and carbon up to four times, titanium up to three times, and chromium and nickel up to one times were observed. And also two forbidden lines of highly ionized titanium (Ti XVII 3834.4 A, Ti XIX 2344.6 A) which were useful for the measurement of titanium density, local ion temperature and plasma rotation were identified. DOE

**N88-11514#** Hiroshima Univ. (Japan). Inst. for Fusion Theory.
**COMPUTATIONAL STUDY OF THREE-DIMENSIONAL MAGNETOHYDRODYNAMIC EQUILIBRIA IN TOROIDAL HELICAL SYSTEMS**
Kenji Harafuji, Takaya Hayashi, and Tetsuya Sato Mar. 1987 88 p
(DE87-753007; HIFT-132) Avail: NTIS (US Sales Only) HC A05/MF A01

Computational methods based on the time-dependent relaxation technique for obtaining finite beta stellarator equilibria with no net current are described. The computation grid is Eulerian corresponding to space-fixed non-orthogonal helical coordinates. The poloidal cross-section, which is composed of rectangular grids, rotates with the same pitch as that of external helical conductors along the toroidal direction. By this choice, it is possible to handle complicated field topologies and to economize the computer memory. Also, numerical convergence is greatly improved compared with that in cylindrical coordinates. The developed code is applied to two typical l = 2 stellarators (Wendelstein VII-A and Heliotron-E). DOE

**N88-11515#** Hiroshima Univ. (Japan). Inst. for Fusion Theory.
**ANALYSIS OF ENERGY CONFINEMENT OF SLIDEAWAY DISCHARGES**
S.-I. Itoh, K. Itoh, and A. Fukuyama Jan. 1987 27 p
(DE87-753008; HIFT-130) Avail: NTIS (US Sales Only) HC A03/MF A01

The anomalous transport of electrons in the slide-away discharges of tokamak plasma is examined. The tail-current operation is analyzed by combining the Fokker-Planck equation and the radial transport equation. The theoretical model is made with inclusion of the correction in the collisionless limit for the thermal diffusivities of both the tail and the bulk electrons. In the slide-away regime, results show the reduction of the one turn voltage, (V sub lsup proportional to n sup 0.5 (n: density)), the increase of the tail component, and the constancy of the central electron temperature. The model recovers the Alcator law in the usual ohmic discharge. This shows the reduction of the anomalous loss even in the presence of the direct tail loss. Comparison with experiments is made. Experimental observation seems to show the further reduction of the loss. DOE

**N88-11516#** Japan Atomic Energy Research Inst., Tokyo.
**VECTORIZATION OF MHD EQUILIBRIUM AND STABILITY CODES**
Toshiyuki Nemoto and Toshihide Tsunematsu Apr. 1987 40 p
(DE87-753013; JAERI-M-87-062) Avail: NTIS (US Sales Only)
HC A03/MF A01

An MHD equilibrium code (SELENE) and a stability code (ERATO-J) are extensively used for the analysis of ideal MHD beta limit of a tokamak plasma. High efficiency is required for the analysis of experimental data and the design of the next step fusion experimental devices. In the report, the methods of vectorization are described as well as the basic equations and numerical methods. Vectorization reduces the computational time to about a third through a quarter of the original version on Fujitsu VP-100. DOE

**N88-11517#** Japan Atomic Energy Research Inst., Tokyo.
**REACTIVITY FOR DT PLASMA WITH BEAM-INDUCED TAIL IN MAGNETIC CONFINEMENT SYSTEM**
Tomonori Takizuka and Mitsuru Yamagiwa May 1987 26 p
(DE87-753017; JAERI-M-87-066) Avail: NTIS (US Sales Only)
HC A03/MF A01

The reactivity for a DT plasma in the magnetic confinement system is presented by useful and simple equations. The reactivity for a DT Maxwellian plasma is given as a function of the ion temperature, and that enhanced by the beam-induced deuteron tail is shown as a function of the ion and electron temperatures, the injection energy, and the beam power density. By using these simple expressions, the fusion power multiplication in a beam-heated plasma is studied on the basis of a local analysis. The value of n/sub e/tau/sub E/ to achieve Q = 1 (n/sub e/: electron density, tau/sub E/: gross energy confinement time, Q: fusion power multiplication factor) becomes smaller by 2.7/T/sup 1.1/ (keV) than that in a Maxwellian plasma without tail component for the plasma temperature of 5 keV less than T less than 8 keV. DOE

**N88-11518#** Japan Atomic Energy Research Inst., Tokyo.
**FUSION REACTIVITY ENHANCEMENT DUE TO ION TAIL FORMATION BY BEAM AND ION CYCLOTRON HEATING**
Mitsuru Yamagiwa, Tomonori Takizuka, and Yasuaki Kishimoto May 1987 39 p
(DE87-753018; JAERI-M-87-065) Avail: NTIS (US Sales Only)
HC A03/MF A01

Fusion reactivity enhancement due to ion tail formation by NBI (neutral-beam (D sup 0) injection) and second harmonic ICH (ion (D sup +) cyclotron heating) in a 50:50 D-T plasma is investigated on the basis of local Fokker-Planck calculation. Deformation of the deuteron velocity distribution function is examined analytically and comparison is made with numerical results by using a Fokker-Planck code. The reactivity is given by less than sigma upsilon greater than = integral of d upsilon vector f (upsilon vector) G (upsilon) where f is the deuteron distribution and G is called sigma upsilon-function averaged by the isotropic triton distribution. The profile of the integrand typically presents two humps in velocity space for the beam-induced tail. This results in large reactivity enhancement for high energy beam injection. For the case of the RF (radio frequency)-induced tail, a wing

rather than a hump is formed. ICRF (ion cyclotron range of frequency) waves well couple with the beam-induced tail ions and enhance the reactivity, especially when the beam is injected perpendicularly to the magnetic field. The possibility that the combined effects of NBI and second harmonic ICH can exceed each effect on the reactivity enhancement in the efficiency is indicated. DOE

**N88-11519#** Oak Ridge National Lab., Tenn.
**PROGRESS IN STELLARATOR/HELIOTRON RESEARCH, 1981-1986: EXECUTIVE SUMMARY**
B. A. Carreras, G. Grieger, J. H. Harris, J. L. Johnson, J. F. Lyon, O. Motojima, F. Rau, H. Renner, J. A. Rome, and K. Uo Sep. 1987 22 p
(Contract DE-AC05-84OR-21400)
(DE88-000017; ORNL/TM-10482) Avail: NTIS HC A03/MF A01

Substantial progress in plasma parameters, physics understanding, and stellarators/heliotron concept improvement has been made in the five years since a previous assessment of the field. This includes substantial achievements in higher plasma parameters and currentless plasma operation; new theoretical results with respect to higher beta limits, second stability region, effect of a helical axis, effect of electric fields on transport, and reduction of secondary currents; and improvements to the reactor concept. The key issues have been further refined, and the short-term direction of the program is clear; a number of new facilities that were designed to resolve these issues are about to come into operation or are in the final design stages. Details of the design of the next-generation experiments will follow from the results of the near-term experiments. DOE

**N88-11520#** Oak Ridge National Lab., Tenn.
**PLANNING FOR US ION CYCLOTRON HEATING RESEARCH RELEVANT TO THE COMPACT IGNITION TOKAMAK AND ALCATOR C-MOD**
D. W. Swain and J. J. Yugo Aug. 1987 74 p
(Contract DE-AC05-84OR-21400)
(DE88-000022; ORNL/TM-10464) Avail: NTIS HC A04/MF A01

Ion cyclotron heating (ICH) has been chosen as the primary method for providing auxiliary heating power to the plasma in the Compact Ignition Tokamak (CIT). Sustained progress in ion cyclotron range of frequencies (ICRF) heating experiments, together with supporting technology development, continues to justify selection of this technique as the preferred one for heating CIT to ignition. However, the CIT requirements are sufficiently different from existing achievements that continued experimentation and development are needed to meet the goals of the CIT experiment with a high degree of reliability. The purpose of this report is fourfold: (1) to review briefly the physics and technology research and development (R and D) needs for ICH on CIT, (2) to review the status of and planned programs for ICH on US and international machines, (3) to propose a unified mainline R and D program specifically geared to testing components for CIT, and (4) to assess the needs for experiments including C-Mod, the Tokamak Fusion Test Reactor (TFTR), and DIII-D to provide earlier information and improved probability of success for CIT ICH. DOE

**N88-11521#** Oak Ridge National Lab., Tenn.
**RELATIVE MERITS OF SIZE, FIELD, AND CURRENT ON IGNITED TOKAMAK PERFORMANCE: A COMPARISON OF CITs AND SUPER-JETs**
N. A. Uckan Aug. 1987 36 p
(Contract DE-AC05-84OR-21400)
(DE88-000038; ORNL/TM-10365) Avail: NTIS HC A03/MF A01

A simple global analysis is used to examine the relative merits of size (L = a or R sub 0), field (B sub 0), and current (I) on ignition regimes of Tokamaks under various confinement scaling laws. Scalings of key parameters (n tau(sub E), Beta, P(sub aux), P(sub fus), etc.) with L, B sub 0, and I are presented at several operating points, including: (1) optimal path to ignition (saddle point); (2) ignition at minimum beta; (3) ignition at 10 keV; and (4) maximum performance at the limits of density (n(sub max) approx. B sub 0/R sub 0) and beta (Beta (sub crit) approx. I/aB sub 0). Expressions for the saddle point and the minimum conditions needed for Ohmic ignition are derived analytically for any confinement model of the form tau(sub E) approx. n(sup x)T(sup y). For a wide range of confinement models, the figure of merit parameters aB sup 2 sub 0/q dot approx. IB sub 0(R sub 0/a) are found to give a good indication of the relative performance of the devices, where q dot is the cylindrical safety factor. As an illustration, the results are applied to CITs (a class of compact, high-field ignition Tokamaks) and Super-JETs (a class of large-size (few X JET), low-field, high-current (20-MA) devices). DOE

**N88-11522#** Oak Ridge National Lab., Tenn.
**FEASIBILITY OF ALPHA PARTICLE MEASUREMENT IN A MAGNETICALLY CONFINED PLASMA BY CO2 LASER THOMSON SCATTERING**
R. K. Richards, K. L. VanderSluis, and D. P. Hutchinson Aug. 1987 28 p
(Contract DE-AC05-84OR-21400)
(DE88-000039; ORNL/TM-10363) Avail: NTIS HC A03/MF A01

Fusion-product alpha particles will dominate the behavior of the next generation of ignited D-T fusion reactors. Advanced diagnostics will be required to characterize the energy deposition of these fast alpha particles in the magnetically confined plasma. For small-angle coherent Thomson scattering of a CO2 laser beam from such a plasma, a resonance in the scattered power occurs near 90 degrees with respect to the magnetic field direction. This spatial concentration permits a simplified detection of the scattered laser power from the plasma using a heterodyne system. The signal produced by the presence of fusion-product alpha particles in an ignited plasma is calculated to be well above the noise level, which results from statistical variations of the background signal produced by scattering from free electrons. DOE

**N88-11523#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**STABILITY OF SPHEROIDAL SPHEROMAK PLASMA BY USE OF FORCE-FREE APPROXIMATION**
Shobu Kaneko and Hiroaki Tsutsui Sep. 1987 25 p
(IPPJ-846; ISSN-0469-47322) Avail: NTIS HC A03/MF A01

The Woltjer-Taylor method is applied to spheromak plasmas in spheroid flux conservers. As models of the flux conserver, both oblate and prolate spheroidal vessels with a center conductor are used. The plasma is not assumed to be nearly spherical, and the Rayleigh-Ritz method and finite element method are used to evaluate the eigenvalues. The oblate spheromak is shown to be stable irrespective of the shape of the flux conserver. Though the prolate spheromak is unstable if there is no center conductor, it can be stable if the center conductor is installed. Author

**N88-11524#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**MAGNETOHYDRODYNAMIC STABILITY OF SPHEROMAK PLASMA IN TOROIDAL FLUX CONSERVER WITH RECTANGULAR CROSS SECTION 3. STABILITY FOR SYMMETRIC MODES**
Shobu Kaneko, Yi Ping Wang, and Hiroaki Tsutsui Sep. 1987 8 p
(IPPJ-845; ISSN-0469-4732) Avail: NTIS HC A02/MF A01

The Edenstrasser's condition is applied to the spheromak plasma in the toroidal flux conserver with the rectangular cross section. The application of this condition is also applied to the spheromak plasma with optimized pressure distribution. B.G.

**N88-11525#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**LONG WAVELENGTH VORTICES OF LOW FREQUENCY INTERCHANGE MODES**
Vladimir P. Pavlenko and Heiji Sanuki Sep. 1987 23 p
(IPPJ-844; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

Nonlinear coupled equations describing the low frequency interchange modes in a plasma with small fraction of the hot electron component are derived on the basis of multi-fluid

equations. Stationary vortex solutions in a long wavelength limit are obtained in a plasma stabilized by the charge uncovering effect instead of the finite Larmor radius effect. The solution takes a form of a pair of localized vortices, rotating in opposite directions and moving with a constant velocity in direction perpendicular to the magnetic field. The linear dispersion relation is studied in detail. The dispersion relation of vortex, relating the propagation velocity to the core size of vortex is examined for typical parameters in bumpy torus experiments. Consequently, the positive and negative branches of the propagation velocity for the fixed size of vortex are also found. Author

**N88-11526#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**POTENTIAL FORMATION IN THE PLASMA CONFINEMENT REGION OF A RADIO-FREQUENCY PLUGGED LINEAR DEVICE**
Hideki Fujita, Ryuhei Kumazawa, Arthur M. Howald, Shoichi Okamura, Teruyuki Sato, Keizo Adati, Harold R. Garner, and Kiyohiko Nishimura Aug. 1987 33 p
(IPPJ-843; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

Plasma potential formation in an open-ended plasma confinement system with RF plugging (the RFC-XX-M device) is investigated. The plasma potential in the central confinement region is measured with a heavy ion beam probe system and potentials at the RF plug section are measured with multigrid energy analyzers. The measured plasma potential is compared with that deduced from the generalized Pastukhov formula. Results show that the plasma potential develops as an ambipolar potential to equate ion and electron end losses. During RF plugging, electrons are heated by Landau damping, while ion are not heated since adiabatic conditions apply during ion plugging in this experiment. Author

**N88-11527#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**FRACTURE MECHANISM OF FINE GRAIN GRAPHITE UNDER HIGH HEAT FLUXES**
H. Bolt, A. Miyahara, and T. Kuroda Aug. 1987 26 p
(IPPJ-842; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

During the operation in fusion devices graphite in-vessel components can be subjected to severe heat loads. Component fracture which may occur under these loads can seriously check the further operation of the entire device. The fracture process under high heat loads is examined on the fine grain graphite Poco AXF-5Q. Laboratory samples which were subjected to pulsed heat loads by a hydrogen beam are compared to a limiter of the same material which suffered fracture damage during operation in the JIPP T-IIU tokamak. The process of fracture under high heat flux can be described with a two stage model of crack initiation and subsequent crack propagation. Cracks are initiated by shear under compressive stresses in a highly heated surface layer. The further crack propagation follows the cyclic heat loads and is mainly driven by tensile stresses until fracture occurs. The results of these observations are the basis for efforts to assure reliable component operation under high heat fluxes. Author

**N88-11528#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**SIMULATION OF TOKAMAK RUNAWAY-ELECTRON EVENTS. STUDY OF THE RESPONSE OF MATERIALS BY USE OF AN ELECTRON LINEAR ACCELERATOR**
H. Bolt, A. Miyahara, M. Miyake, and T. Yamamoto Aug. 1987 21 p
(IPPJ-841; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

High energy runaway electron events which can occur in tokamaks when the plasma hits the first wall are a critical issue for the materials selection of future devices. Runaway electron events are simulated with an electron linear accelerator to better understand the observed runaway electron damage to tokamak first wall materials and to consider the runaway electron issue in further materials development and selection. The electron linear accelerator produces beam energies of 20 to 30 MeV at an integrated power input of up to 1.3 kW. Graphite, SiC + 2 percent AlN, stainless steel, molybdenum and tungsten were tested as bulk materials. To test the reliability of actively cooled systems under runaway electron impact layer systems of graphite fixed to metal substrates were tested. The irradiation resulted in damage to the metal compounds but left graphite and SiC + 2 percent AlN without damage. Metal substrates of graphite - metal systems for actively cooled structures suffer severe damage unless thick graphite shielding is provided. Author

**N88-11529#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**WAVEPACKET PROPAGATION AND CURRENT STARTUP NEAR THE LOWER HYBRID FREQUENCY IN THE TORUS**
K. Ohkubo, Y. Matsumura, M. Mizuno, M. Matsuoka, and K. Matsuura Aug. 1987 26 p
(IPPJ-840; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

In addition to the two-dimensional propagation of wavepacket, electron heating, and current drive by a lower hybrid wave in afterglow plasmas are investigated in a small torus. Because the wavepacket, which has a wide frequency spectrum, spreads in space and time due to dispersion, the pulse width of a received wavepacket accompanied with frequency shift increases. The experimental results including the direct observed group and phase velocities agree with the theoretical analysis. Lower hybrid waves with low power (less than 10 W and equal to or approximately 100 microseconds) above the threshold power (equal to or approximately 0.3 W) are observed which heat electrons and drive the toroidal current. The power threshold is related to the power dependence on parametric instability. It is pointed out that parametrically excited lower hybrid waves take part in both electron heating and filling up the spectral gap which is closely related to current startup. Author

**N88-11530#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**FILAMENTATION INSTABILITY OF ROTATING LIGHT ION BEAMS IN FUSION TARGET CHAMBERS**
Toshio Okada and Keishiro Niu Jul. 1987 12 p
(IPPJ-839; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

Filamentation instability for a rotating light ion beam (LIB) fusion system is investigated. Stability conditions including the effects of fractional current neutralization, rotation of LIB, and beam temperature are derived for propagation through a background plasma. The results are illustrated by plotting stability boundaries for a rotating proton beam propagating in a plasma. Author

**N88-11531#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**VOLUME PRODUCED H(-),D(-) ION SOURCE FOR PROTON ACCELERATOR AND THERMO-NUCLEAR FUSION RESEARCH BY SHEET PLASMA (III)**
Joshin Uramoto Jul. 1987 12 p
(IPPJ-838; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

The volume produced H(-) ion current is extracted from the outside region of a high efficiency sheet plasma of width nearly equal to 25 cm, thickness nearly equal to 0.8 cm, and length along a weak magnetic field nearly equal to 30 cm. The number of extraction apertures (6 mm phi) is changed from 9 to 301. With a high discharge anode current of 150 A and a H2 gas pressure of .002 Torr, the extracted H(-) ion current at 4 kV is about 2.0 A in a case of 301 apertures (160 sq cm, transparency nearly equal to 50 percent). The H(-) ion current is nearly proportional to the number of apertures, and the H(-) ion current density in one aperture is about 24 mA/sq cm. Thus, a H(-)/D(-) ion source based on the sheet plasma is proposed for a future thermonuclear fusion research. Author

**N88-11532#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**LIMIT OF POSSIBLE OPERATION OF CRESCENT AND BEAN SHAPED TOKAMAKS**
H. Naitou and K. Yamazaki Jul. 1987 61 p
(IPPJ-837; ISSN-0469-4732) Avail: NTIS HC A04/MF A01

The maximum attainable beta values which can be expected by the crescent (BEAN1) and rounded bean (BEAN2) shaped Tokamaks are obtained numerically by using the linear ideal MHD stability code ERATO. The current profiles are optimized with the fixed pressure profile for the higher beta value keeping Mercier, high n ballooning, and n = 1 kink modes stable. Triangularity and

identation dependences of the maximum beta value are investigated carefully. The beta value of 10-17 percent is obtained depending on the shape and triangularity (indentation). It is also shown that the coefficient of the Troyon-type beta scaling enhances for the indented plasma. In the case of the small indentation, the BEAN1 shape tokamak characterized by mild indentation and high trangularity shows a higher beta value than BEAN2. For strong indentation, the BEAN2 shape Tokamak gives the highest beta value, although this configuration is unstable at low beta for the n = 1 mode; the operational scenario to reach the maximum beta must be carefully planned. For equilibria with sufficient indentation, the closer wall will largely enhance the maximum beta value because the n = 1 kink mode is limiting beta and the ballooning beta boundary is much higher. Author

**N88-11533#** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fuer Extraterrestrische Physik.
**THE DUSKSIDE PLASMAPAUSE/RING CURRENT INTERFACE: CONVECTION AND PLASMA WAVE OBSERVATIONS**
J. LaBelle, R. A. Treumann, W. Baumjohann, G. Haerendel, N. Sckopke, G. Paschmann, and H. Luehr Jul. 1987 37 p
(MPE-Preprint-93; ASP-63; ETN-87-91038) Avail: NTIS HC A03/MF A01

Data from three AMPTE satellite crossings of the plasmapause were analyzed. The inner edge of the ring current ions, which penetrate the duskside plasmapause by 0.5 to 2 RE is characterized by termination of the plasmaspheric hiss and an outward pointing gradient in the energetic ions. An eastward current is detectable by the plasma instrument as well as the magnetometer; this current is consistent in direction and magnitude with the diamagnetic current associated with the observed gradient in the ring current ions. In two of the three cases, current driven lower hybrid waves occur. On all three days, the ring current overlap with the plasmasphere is marked by sunward convection (opposite to corotation) and by a plateau formation in the density profile, both of which indicate that the ring current has a significant effect on the electric field. ESA

**N88-11534#** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fuer Extraterrestrische Physik.
**CURRENT-DRIVEN LOWER HYBRID WAVES AT THE INNER EDGE OF THE RING CURRENT**
J. LaBelle and R. A. Treumann Jul. 1987 20 p
(MPE-Preprint-94; ASP-64; ETN-87-91039) Avail: NTIS HC A03/MF A01

Waves near the lower hybrid frequency observed in association with the diamagnetic current at the inner edge of the ring current are interpreted in terms of the modified two-stream instability, generalized to include two ion components: the cold ions of the background plasma and the hot drifting ring current ions. Solution of the dispersion relation yields a Weak instability. Since the waves are Landau damped by the background ions, the instability depends sensitively on the background ion temperature as well as the drift velocity. The general characteristics of the observed waves are determined fairly well by the linear theory. Estimates of the saturation level suggest that the waves saturate due to flattening of the current ion distribution function. ESA

**N88-11535** Max-Planck-Inst. fuer Plasmaphysik, Garching (West Germany).
**LASER BLOW-OFF EXPERIMENTS ON ASDEX**
C. Setzensack Feb. 1987 25 p In GERMAN; ENGLISH summary Sponsored by Euratom
(IPP-III/119; ETN-87-91045) Copyright Avail: Fachinformationszentrum, Karlsruhe, Fed. Republic of Germany

A laser blow-off system was installed on the ASDEX Tokamak and used in investigations of the impurity behavior under different plasma conditions. Results reveal considerable improvement of the impurity confinement time in OH plasmas near the density limit; influence of impurities on edge localized modes; strong dependence of the impurity confinement time on the gradient of the plasma current; and different impurity confinement under various heating conditions. ESA

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Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**N88-11536#** Los Alamos National Lab., N. Mex. Theoretical Div.
**COMPLEX SCATTERING DYNAMICS AND THE INTEGER QUANTUM HALL EFFECT**
S. A. Trugman and F. R. Waugh (Princeton Univ., N. J.) 1987 7 p Presented at the 7th Electronic Properties of Two-Dimensional Systems, Santa Fe, N. Mex., 27-31 Jul. 1987
(Contract W-7405-eng-36)
(DE87-011790; LA-UR-87-1910; CONF-870774-1) Avail: NTIS HC A02/MF A01

The effect of a magnetic field on potential scattering is investigated microscopically. A magnetic field renders the scattering of a classical charged particle far more complex than previously suspected. Consequences include possible 1/f noise and an explanation of the observed breakdown of the quantum Hall effect at large currents. A particular scatterer is described by a discontinuous one dimensional Hamiltonian map, a class of maps that has not previously been studied. A renormalization group analysis indicates that singular behavior arises from the interplay of electron orbits that are periodic and orbits that are quasiperiodic. DOE

**N88-11537#** Sandia National Labs., Albuquerque, N. Mex.
**SOLUTE SEGREGATION TO PHASE INTERFACES AND GRAIN BOUNDARIES: STUDIES BY ANALYTICAL ELECTRON MICROSCOPY AND PROFILE DECONVOLUTION**
A. D. Romig, Jr. and M. J. Cieslak 1987 21 p Presented at the Pacific Workshop and Meeting on Analytical Electron Microscopy, Kona, Hawaii, 12 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012129; SAND-87-1773C; CONF-870733-4) Avail: NTIS HC A03/MF A01

Mathematical deconvolution of the observed composition profiles at the interface or boundary with the X-ray generation profile to determine the actual composition profile is a viable procedure for extracting compositional data on a spatial scale smaller than the inherent resolution of thin foil X-ray microanalysis. In sufficiently thin foils, the X-ray generation profile can be calculated with the single scattering model. In thicker foils, the X-ray generation profile can be calculated with Monte Carlo techniques. Explicit deconvolution is, in general, not possible mathematically, but it can be accomplished numerically through iterative convolutions. Convolution of the X-ray generation profile with the assumed actual composition profile allows for direct calculation of the expected composition profile. The convolution procedure using various assumed actual concentration profiles is repeated iteratively until the calculated profile and the observed profile correspond. This paper describes the convolution process and introduces a rapid graphical solution to the problem, compares the convolution process using the single scattering model and Monte Carlo techniques, and discusses the limitations of the deconvolution procedure. This study uses the recently reported data of Ti enrichment at grain boundaries in an Fe-Ni superalloy (Alloy 800). DOE

**N88-11538#** Sandia National Labs., Albuquerque, N. Mex.
**VARIATIONS IN SEMICONDUCTOR DEVICE RESPONSE IN A MEDIUM-ENERGY X-RAY DOSE-ENHANCING ENVIRONMENT**
David E. Beutler, D. M. Fleetwood, W. Beezhold, D. Knott, L. J. Lorence, Jr., and B. L. Draper 1987 27 p Presented at the 24th Annual Conference on Nuclear and Space Radiation in Electronics, Snowmass, Colo., 28 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012400; SAND-87-1615C; CONF-870724-17; Paper-G-4)
Avail: NTIS HC A03/MF A01

The response of semiconductor devices to medium-energy x-ray irradiation was investigated under conditions in which dose-enhancement effects are very important. The response of

MOS capacitors to dose-enhanced radiation can depend on incident radiation spectra, temperature of the device, and oxide electric field. Indeed, the amount of enhanced response can vary by as much as a factor of 10 as these conditions are changed. In such cases, it appears that changes in electron-hole recombination and hole trapping as a function of radiation energy are very important to the interpretation of the results. Therefore, coupled electron/photon transport codes such as the Monte Carlo integrated TIGER series (ITS), which consider only changes in the dose deposited in the device active region, are inadequate, at least in some cases, for predictions of dose-enhancement effects in semiconductor devices. In addition, the response of semiconductor diodes to dose-enhanced radiation appears to be qualitatively different from that of capacitors, and differs markedly in value from code predictions. Hence, an understanding of the modification of incident radiation by its interactions with dose-enhancing materials alone is insufficient to predict the response of semiconductor devices. The dependence of the device response on radiation spectra, electron-hole recombination, and hole transport and trapping, must also be included to assure good simulation fidelity of tests for devices to be used in dose-enhancing environments. DOE

**N88-11539#** Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.

**ON THE SEARCH FOR EXPERIMENTALLY OBSERVED GRAIN BOUNDARY PHASE TRANSITIONS**

R. W. Balluffi and T. E. Hsieh Jul. 1987 11 p
(Contracts DE-FG02-84ER-45116; DE-FG02-87ER-45310)
(DE87-012747; DOE/ER-45310/3) Avail: NTIS HC A03/MF A01

The phase space for a heterogeneous system containing a grain boundary involves a relatively large number of variables (i.e., at least six plus the number of components), and it is therefore conceptually possible to induce a large variety of grain boundary phase transitions by selectively varying these parameters. Despite this, a review of the literature reveals that there have been virtually no clear-cut experimental observations of transitions reported in which the boundary structure has been observed as a function of time under well defined conditions. In current work, we are searching for roughening/faceting transitions and melting transitions for boundaries in Al by hot stage transmission electron microscopy. A clear example of a reversible roughening/faceting transition has been found. No evidence for melting has been found for temperatures as high as 0.96 T(sub m) (by monitoring GBD core delocalization in several special boundaries with Sigma less than or equal to 13) or 0.999 T(sub m) (by observing the local diffraction contrast at general boundaries in polycrystalline specimens). DOE

**N88-11540#** Brookhaven National Lab., Upton, N. Y. Physics Dept.

**THEORY OF THE ONE- AND TWO-DIMENSIONAL ELECTRON GAS**

V. J. Emery 1987 10 p Presented at the NATO ASI Meeting on Organic and Inorganic Low Dimensional Crystalline Materials, Minorca-Beleares, Spain, 3 May 1987
(Contract DE-AC02-76CH-00016)
(DE87-012864; BNL-40013; CONF-8705173-1) Avail: NTIS HC A02/MF A01

Two topics discussed at the NATO ASI Meeting on Organic and Inorganic Low Dimensional Crystalline Materials were the following: (1) the competition between 2k(sub F) and 4k(sub F) charge state waves in a one-dimensional electron gas, and (2) a two-dimensional model of high T(sub c) superconductivity in the oxides. DOE

**N88-11541#** Fermi National Accelerator Lab., Batavia, Ill.

**HIGH GRADIENT SUPERCONDUCTING QUADRUPOLES**

R. A. Lundy, B. C. Brown, J. A. Carson, H. E. Fisk, R. H. Hanft, P. M. Mantsch, A. D. McInturff, and R. H. Remsbottom Jul. 1987 3 p Presented at the Particle Accelerator Conference, Vancouver, British Columbia, 13 May 1985 Prepared in cooperation with Stanford Linear Accelerator Center, Menlo Park, Calif.
(Contract DE-AC03-76SF-00515)
(DE87-013590; SLAC-PUB-4364; CONF-850504-316) Avail: NTIS HC A02

Prototype superconducting quadrupoles with a 5 cm aperture and gradient of 16 kG/cm have been built and tested as candidate magnets for the final focus at SLC. The magnets are made from NbTi Tevatron style cable with 10 inner and 14 outer turns per quadrant. Quench performance and multipole data are presented. Design and data for a low current, high gradient quadrupole, similar in cross section but wound with a cable consisting of five insulated conductors are also discussed. DOE

**N88-11542#** California Univ., Berkeley. Lawrence Berkeley Lab.

**SEMICONDUCTOR DETECTOR PERFORMANCE FOR LOW-ENERGY X-RAYS**

J. M. Jaklevic, J. T. Walton, R. E. McMurray, Jr., N. W. Madden, and F. S. Goulding Jun. 1987 15 p Presented at the 5th National Synchrotron Radiation Instrumentation Conference, Madison, Wis., 21 Jun. 1987
(Contract DE-AC03-76SF-00098)
(DE87-014132; LBL-23616; CONF-870610-10) Avail: NTIS HC A03/MF A01

Factors that limit the capabilities of semiconductor detectors at photon energies below 5 keV include energy resolution, detector efficiency, and detector-related continuum background. These properties can be controlled to a certain extent by optimal detector design and fabrication techniques. We describe measurements on the low-energy response of Si(Li) detectors obtained using a tunable, low-energy monochromatic source. Window thicknesses have been measured for a number of devices using different materials for the entry contact. The interpretation of these results in terms of existing detector window models is discussed. Results obtained using a new contact structure demonstrate that a dramatic reduction in window-related absorption in Si(Li) detectors can be achieved. DOE

**N88-11543#** Spire Corp., Bedford, Mass.

**WIDE BANDGAP PASSIVATION LAYERS ON SILICON**

C. Case, G. Landis, R. Beaulieu, J. Loferski, S. M. Vernon, M. B. Spitzer, P. Sekula, C. J. Keavney, and V. Haven 1987 8 p Presented at the 19th IEEE Photovoltaic Specialists Conference, New Orleans, La., 4 May 1987 Prepared in cooperation with Brown Univ., Providence, R.I.
(Contract DE-AC02-84ER-80186)
(DE87-014307; CONF-870528-19) Avail: NTIS HC A02/MF A01

The research problem that has been addressed in this work is the deposition of ZnS, ZnS sub 0.9Se sub 0.1, and GaP, which are candidate lattice-matched wide bandgap materials intended to replace SiO2 passivation on silicon solar cells. Ideally, these films would reflect minority carriers but not impede majority carrier transport to the surface and would passivate beneath contacts. The thin films were deposited by MOCVD, resistance evaporation or sputtering. Epitaxial GaP and ZnS films cause increases of internal quantum efficiency at short wavelengths. Reductions in J sub o comparable to that generated by SiO2, and increases in V sub oc were also observed. Film growth morphology was found to be a function of substrate temperature, orientation and the success of in situ removal of the native oxide. DOE

**N88-11544#** California Inst. of Tech., Pasadena.

**OHMIC CONTACTING SCHEMES TO GALLIUM ARSENIDE DEVICES**

Aug. 1987 50 p Prepared in cooperation with Sandia National Labs., Albuquerque, N. Mex.
(Contract DE-AC04-76DP-00789)
(DE87-014627; SAND-87-7010) Avail: NTIS HC A03/MF A01

The goal of this project was to design ohmic contacting schemes to gallium arsenide that would sustain 400°C for 1 hour and 600°C for 15 minutes without significant degradation. Our approach uses

a generic contacting scheme calling for two thin-film layers between the semiconducting substrate and the metal overlayer: (1) a contacting layer adjacent to the semiconductor that determines the electrical properties of the contact, and (2) a diffusion barrier layer adjacent to the metal overlayer that assures the thermal stability of the contact. A contact designed according to this scheme (silver overlayer, pure tungsten or tungsten-nitrogen layer as the diffusion barrier, and a magnesium-doped platinum film for the contacting layer to p-type gallium arsenide) changes little upon annealing at 550°C for 5 hours. The contact resistivity is on the order of 1E-3 ohm sq cm or less. DOE

**N88-11545#** Oak Ridge National Lab., Tenn.
**DSA RuO2/TIO2 ELECTRODE MODELED BY ION IMPLANTATION: AN IN SITU CHARACTERIZATION BY PHOTOACOUSTIC AND PHOTOCURRENT SPECTROSCOPY**
C. E. Vallet, S. E. Borns, J. S. Hendrickson, and C. W. White 1987 2 p Presented at the 172nd Meeting of the Electrochemical Society, Honolulu, Hawaii, 18 Oct. 1987
(Contract DE-AC05-84OR-21400)
(DE87-009129; CONF-871027-7-Summ) Avail: NTIS HC A02/MF A01

This paper presents a first attempt at in situ characterization of very thin passive layers forming at implanted Ru/Ti alloys by photoacoustic and photocurrent spectroscopies. The photoacoustic spectroscopy gives the optical absorption of the layer. Changes in the spectra in the wavelength region including the absorption band edge of semiconducting n-TiO2 with the Ru concentration should provide a means for monitoring the transition from a semiconducting electrode (at low Ru concentration) to a metallic electrode as the Ru concentration within the oxide increases. The associated photocurrent result is a further test that the monitored optical transition corresponds to the excitation of electrons across the gap from valence to conduction band. DOE

**N88-11546#** California Univ., Berkeley. Lawrence Berkeley Lab.
**ELECTRICAL PROPERTIES OF HIGH T/SUB C/ SUPERCONDUCTORS UNDER HIGH PRESSURES**
D. Erskine, E. Hess, P. Y. Yu, A. M. Stacy, A. Zettl, and M. L. Cohen Jun. 1987 8 p Presented at the Workshop on Novel Mechanisms for Superconductivity, Berkeley, Calif., 22 Jun. 1987
(Contract DE-AC03-76SF-00098)
(DE87-012818; LBL-23692; CONF-870682-3) Avail: NTIS HC A02/MF A01

Pressure has played a significant role in the recent developments of high transition temperature (T sub c) superconductors. This document reports electrical resistance measurements in these new superconductors at pressures up to 16 GPa. Our measurements were performed on single-phase but polycrystalline samples of La(sub 1.85)Ba(sub 0.15)CuO4, La(sub 1.85)Sr(sub 0.15)CuO4 and YBa3Cu4O(sub 7.5). The samples were typically small fragments of about 200 microns across obtained by crushing larger pellets which have been characterized by X-ray, resistivity and magnetic susceptibility measurements at ambient pressure. Quasi-hydrostatic pressure was applied with a diamond anvil high pressure cell. The sample was surrounded by CaSO4 powder as the pressure medium and the pressure was determined by the standard ruby fluorescence technique. Diamond anvils of three different sizes have been utilized to cover these three pressure ranges: 0 to 5 GPa, 2 to 10 GPa, and 3 to 20 GPa. The resistance of the sample was determined by a quasi-four-probe technique via two loops of copper wires. Electrical contact between the copper wire and the sample was achieved by pressure. DOE

**N88-11547#** Sandia National Labs., Albuquerque, N. Mex.
**QUICKSILVER: A 3D, ELECTROMAGNETIC, PIC CODE**
D. B. Seidel, M. L. Kiefer, R. S. Coats, A. L. Siegel, and J. P. Quintenz 1987 4 p Presented at the 12th Conference on the Numerical Simulation of Plasmas, San Francisco, Calif., 20 Sep. 1987
(Contract DE-AC04-76DP-00789)
(DE87-013013; SAND-87-1870C; CONF-870947-6) Avail: NTIS HC A02/MF A01

QUICKSILVER is a multitasked, finite difference, 3-dimensional, fully relativistic, electromagnetic, particle-in-cell code currently under development at Sandia National Laboratories. It has been developed for current and near-term supercomputers, such as the Cray X-MP/416, which are characterized by large central memories and multiple processors. All grid-related quantities are stored in central memory and particle information may be stored out of memory if there is not sufficient central memory. The problem geometry is generated with a preprocessor and the simulation results are examined with a postprocessor. This report describes pre- and post-processing capabilities of QUICKSILVER and discusses algorithm development. DOE

**N88-11548#** Sandia National Labs., Albuquerque, N. Mex.
**PHOTOLUMINESCENCE STUDIES OF GaAs/AlAs SUPERLATTICES**
E. D. Jones, T. J. Drummond, H. P. Hjalmarson, and J. E. Schirber 1987 11 p Presented at the 3rd International Conference on Superlattices, Microstructures and Microdevices, Chicago, Ill., 17 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-013817; SAND-87-2038C; CONF-8708112-1) Avail: NTIS HC A03/MF A01

Low-temperature pressure-dependent photoluminescence measurements on short-period GaAs/AlAs superlattice structures are presented. Measurements show that the lower energy conduction-band states are in the AlAs layers and the highest energy valence-band states are located in the GaAs layers. This result is supported by the following three experimental observations: the observed pressure coefficient for the conduction-band to valence-band transition energy is negative, the magnetic mass of this transition is heavy, and the band-to-band absorption coefficient appears to be small. These experimental observations are in agreement with predictions of tight-binding calculations. DOE

**N88-11549#** Florida State Univ., Tallahassee. Dept. of Physics.
**FINITE SIZE SCALING AND LATTICE GAUGE THEORY**
B. A. Berg 18 Dec. 1986 34 p Presented at the Lattice Gauge Theory Meeting, Upton, N.Y., 15 Sep. 1986
(Contracts DE-FG05-87ER-40319; DE-FC05-85ER-25000)
(DE87-014139; CONF-8609142-8; FSU-SCRI-86-89) Avail: NTIS HC A03/MF A01

Finite size (Fisher) scaling is investigated for four dimensional SU(2) and SU(3) lattice gauge theories without quarks. It allows to disentangle violations of (asymptotic) scaling and finite volume corrections. Mass spectrum, string tension, deconfinement temperature and lattice Beta-function are considered. For appropriate volumes, Monte Carlo investigations seem to be able to control the finite volume continuum limit. Contact is made with Luescher's small volume expansion and possibly also with the asymptotic large volume behavior. DOE

**N88-11550#** Rice Univ., Houston, Tex. Dept. of Physics.
**APPLICATION OF SPIN-SENSITIVE ELECTRON SPECTROSCOPIES TO INVESTIGATIONS OF ELECTRONIC AND MAGNETIC PROPERTIES OF SOLID SURFACES AND EPITAXIAL SYSTEMS**
**Progress Report, 1 Jan. - 31 Dec. 1987**
G. K. Walters and F. B. Dunning Aug. 1987 7 p
(Contract DE-FG05-86ER-45233)
(DE87-014235; DOE/ER-45233/2) Avail: NTIS HC A02/MF A01

Research during the second year of this grant has focussed on: (1) investigation of surface magnetic structure of Ni(III) by Spin-Polarized Low Energy Electron Diffraction (SPLEED) and overhaul of the apparatus to incorporate additional spin-dependent electron spectroscopies and epitaxial growth capabilities; and (2) investigation of dynamics of metastable atom deexcitation at magnetic and adsorbate-covered surfaces using Spin-Polarized Metastable Deexcitation Spectroscopy (SPMDS). DOE

**N88-11551#** Lawrence Livermore National Lab., Calif.
**A FINITE ELEMENT MODEL FOR INDUCTION HEATING OF A METAL CRUCIBLE**
P. M. Gresho and J. J. Derby Jun. 1987 16 p Presented at the American Conference on Crystal Growth, Monterey, Calif., 13-17 Jul. 1987 Submitted for publication
(Contract W-7405-eng-48)
(DE87-014246; UCRL-96019; CONF-870799-1) Avail: NTIS HC A03/MF A01

In support of a combined theoretical and experimental program designed to grow large oxide crystals at Lawrence Livermore National Laboratory, a quantitative model of the induction heating process for the Czochralski crystal growth technique is developed. When integrated into the overall thermo-capillary-hydrodynamic model, this sub-model will provide the driving force for the entire process by describing the spatially-varying heat generation rate in the metal crucible. The development of this sub-model is presented and applied to some typical cases of interest. DOE

**N88-11552#** Academy of Sciences (USSR), Kiev. Inst. Yadernykh Issledovanij.
**INTERACTION BETWEEN DEFECTS AND THE FORMATION OF DISSIPATIVE STRUCTURES IN IRRADIATED IMPURE CRYSTALS**
P. A. Selishchev and V. I. Sugakov 1986 19 p In RUSSIAN
(DE87-703125; KIYI-86-21) Avail: NTIS (US Sales Only) HC A03/MF A01

A stability is investigated of space-homogeneous distribution of free and captured by saturated flows the interstices and vacancies in irradiated crystals taking into account the elastic interaction between defects. The homogeneous distribution at critical parameters is shown to be unstable in respect of the formation of periodic structure of defect density. The critical parameters are determined, the period of formed structure, its dependence on irradiation conditions (the rate damage, the temperature) and the crystal properties (impurity concentrations, elastic constants) are found. DOE

**N88-11553#** Los Alamos National Lab., N. Mex.
**THIN FILM MICROSTRUCTURES: SIMULATION AND THEORY**
A. Mazor, D. J. Srolovitz, P. S. Hagan, and B. G. Bukiet Aug. 1987 8 p Presented at the 31st SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, Calif., 16 Aug. 1987
(Contract W-7405-eng-36)
(DE87-014732; LA-UR-87-2679; CONF-8708110-8) Avail: NTIS HC A02/MF A01

The nature of the microstructure of physical vapor-deposited films depends sensitively on the substrate temperature during deposition. At low temperatures the microstructure is porous and ballistic aggregation-like, at intermediate temperatures the microstructure is columnar, and at elevated temperatures the grains are three dimensional. These different microstructural regimes are known as Zone 1, 2, and 3, respectively. A theoretical analysis is presented in which the temporal evolution of the columnar microstructure (Zone 2) is studied. The columnar microstructure is shown to be a balance between shadowing (which results in Zone 1 microstructures) and surface diffusion (which tends to smooth the surface). In addition to predicting the proper microstructure, this analysis properly predicts the temperature at which the Zone 2 to Zone 1 microstructural transition occurs. Since bulk diffusion is negligible and surface diffusion controls the microstructure in Zone 2, the microstructure in the bulk of the film may be viewed as frozen, and all microstructural evolution occurs at the current, or active, surface. A Monte Carlo computer simulation technique which models the microstructural evolution of the surface is presented. The simulation follows the temporal evolution of realistic three dimensional Zone 2 microstructures and accounts for growth competition between adjacent grains and the formation of film texture. DOE

**N88-11554#** Japan Atomic Energy Research Inst., Tokyo.
**COMPUTER SIMULATIONS OF KNOCK-ON PROCESSES IN bcc Ta CRYSTAL**
Motomasa Fuse, Yukichi Taji, and Tadao Iwata Feb. 1987 29 p In JAPANESE; ENGLISH summary
(DE87-752980; JAERI-M-87-026) Avail: NTIS (US Sales Only) HC A03/MF A01

Knock-on processes in bcc tantalum crystal have been investigated by using molecular dynamical program GRAPE. Adopted interatomic potential is the Johnson type which is determined by fitting to experimental values such as elastic constants. The obtained results are summarized as follows. (1) Self-interstitials produced by knock-on process in Ta crystal can be classified into two types; one is (100) and (111) crowdion, and the others are their variations. This point is quite different from the case found in bcc Fe and Mo, in which case only (110) split dumbbell configuration is produced. (2) Calculated distribution of threshold energy for Frenkel-pair production coincides fairly well with the experimental results. DOE

**N88-11555#** Toulouse Univ. (France). Lab. d'Automatique et d'Analyse des Systemes.
**STUDY AND OPTIMIZATION OF A TECHNOLOGICAL PROCESS FOR THE FABRICATION OF HETEROJUNCTION BIPOLAR TRANSISTORS. APPLICATIONS TO HIGH SPEED DEVICES Ph.D. Thesis - Paul Sabatier Univ.**
Mohamed Jalal Termanini 1987 167 p In FRENCH; ENGLISH summary
(LAAS-87-134; ETN-87-90641) Avail: NTIS HC A08/MF A01

The main manufacturing techniques including liquid phase epitaxy, molecular beam epitaxy, and metal organic chemical vapor deposition are investigated for GaAs devices. Improvements are suggested in each case. The different technological steps available for the entire transistor fabrication are analyzed, and an optimum process is determined. ESA

**N88-11556#** Toulouse Univ. (France). Lab. d'Automatique et d'Analyse des Systemes.
**MOLECULAR BEAM HETEROEPITAXY: (Ca,Sr)F2-GaAs SYSTEM Ph.D. Thesis - Paul Sabatier Univ.**
Chantal Fontaine 1987 274 p In FRENCH; ENGLISH summary
(LAAS-87-168; ETN-87-90644) Avail: NTIS HC A12/MF A01

The mechanisms accounting for defect nucleation during crystal growth, as well as the stress on the layers and the possibility of stress relaxation by defect generation are studied. Experimental results are obtained for (Ca,Sr)F2/GaAs and GaAs(Ca,Sr)F2 structures elaborated by molecular beam epitaxy. The properties of the interfaces, the epitaxial relationships, the growth mechanisms, and the stresses are considered. The results have general interest and may be applied to systems different from GaAs or Si systems. ESA

**N88-11557#** Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Technische Physik.
**PROPERTIES OF Nb3Sn SUPERCONDUCTOR WIRES WITH COMPOSITE CORES**
S. Gauss May 1987 78 p In GERMAN; ENGLISH summary
(KfK-4263; ISSN-0303-4003; ETN-87-91032) Copyright Avail: NTIS HC A05/MF A01

In order to increase the pinning forces, Nb3Sn wires with filaments containing normal conducting inclusions were produced. The classical alloyed cores produced by melting were replaced by powder metallurgical ones consisting of mixtures from Nb and X powders (X = Ta, Ti, Ni, NbTi) pressed, extruded, and processed to rods. The further processing for 19 core wires was made by the bronze route. The wires were reacted for 64 to 120 hr at 625 to 750 C. Depending on the reaction temperature, a smaller or larger amount of the addition element dissolves in the superconducting A15 phase. By optimizing the reaction conditions, an envelope above classical binary and ternary Jc vs B curves is achieved, with simultaneously excellent carrying capacity at low and high fields. In the region 11 to 12 T (crossover for classical

processed wires) the increase of wires with artificial pinning centers with respect to classical ones is 70%. ESA

# 77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

**N88-11558#** Rice Univ., Houston, Tex. Dept. of Chemical Engineering.
**APPLICATION OF NEW CONFORMAL SOLUTION THEORIES Annual Report, Jan. - Dec. 1986**
D. D. Erickson, L. J. Chen, R. Tan, Y. J. Kwon, and T. W. Leland 11 May 1987 124 p
(Contract GRI-5086-260-1260)
(PB87-211934; GRI-87/0047) Avail: NTIS HC A06/MF A01 CSCL 20M

The report summarizes work carried out at Rice University in 1986, i.e., improvement on earlier work on thermodynamic models used to predict the properties of liquid and vapor mixtures. This year's results include: a Monte Carlo simulation of spherocylinders; improvements of the hard convex body equation of state; and several nonanalytic equations of state for light hydrocarbons. GRA

**N88-11559#** International Centre for Theoretical Physics, Trieste (Italy).
**QUANTUM MECHANICS WITH SPONTANEOUS LOCALIZATION AND THE QUANTUM THEORY OF MEASUREMENT**
F. Benatti, G. C. Ghirardi, A. Rimini, and T. Weber Oct. 1986 18 p
(DE87-703072; IC-86/331) Avail: NTIS (US Sales Only) HC A03/MF A01

Recently a modification of quantum dynamics allowing a unified description of microscopic and macroscopic systems has been introduced. We investigate here the consequences of this approach for the measurement problem. We show that in this way one gets a consistent and objective solution of the problem of the wave packet reduction. DOE

**N88-11560#** International Centre for Theoretical Physics, Trieste (Italy).
**REGULAR EFFECTIVE ACTION OF GAUGE FIELD THEORY AND QUANTUM GRAVITY**
N. S. Baaklini Oct. 1986 60 p
(DE87-703076; IC-86/342) Avail: NTIS (US Sales Only) HC A04/MF A01

We present a perturbative formalism for the effective quantum action of a general Fermi-Bose field theory. We propose a unitary alternative to the conventional virtual ghost prescription for handling the functional integral of gauge fields, based on the functional space metric that is determined by the Dirac brackets of the Canonical theory. A gauge-invariant Gaussian cutoff is introduced by extending the functional space metric into a regular counterpart. The regular one-loop contributions of a scalar field to the photon and the graviton self-energies are computed. The otherwise logarithmically divergent contributions are found, in our scheme, to be independent of cutoff. DOE

**N88-11561#** International Centre for Theoretical Physics, Trieste (Italy).
**SUPERCONFORMAL INVARIANCE AND SUPERSTRING IN BACKGROUND FIELDS**
G. Aldazabal, F. Hussain, and R. Zhang Dec. 1986 21 p
(DE87-703097; IC-86/400) Avail: NTIS (US Sales Only) HC A03/MF A01

We consider the propagation of the superstring on a general classical background containing the effects of the metric, the antisymmetric tensor and the dilaton fields. Using the operator product expansion method for two dimensional superconformal field theories we derive the equations for these fields as a consequence of the superconformal invariance of the theory. DOE

**N88-11562#** International Centre for Theoretical Physics, Trieste (Italy).
**ON THE COSMOLOGICAL CONSTANT IN THE HETEROTIC STRING THEORY**
E. Gava and R. Iengo Jan. 1987 7 p
(DE87-703099; IC-86/403) Avail: NTIS (US Sales Only) HC A02/MF A01

We examine the possible physical assumptions which can be made in the heterotic string theory in order to derive the vanishing of the cosmological constant within the theory of modular forms on the moduli space. It seems that more mathematical information is needed to reach a definite result. DOE

**N88-11563#** Lanchester Polytechnic, Coventry (England). Dept. of Mathematics.
**SUPERLUMINAL VELOCITIES WITHIN RELATIVITY THEORY**
R. J. Low May 1987 8 p
(ETN-87-90958) Avail: NTIS HC A02/MF A01

Observations (Blandford et al 1977, Cohen et al 1977) of distant galaxies which have apparent velocities of separation greater than 2c are considered. It is shown that such velocities can be observed within the framework of the general theory of relativity, and need not imply physical velocities greater than that of light. ESA

# 80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

No abstracts in this category.

# 81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

No abstracts in this category.

# 82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

**N88-11564#** Lawrence Livermore National Lab., Calif.
**DESIGN AND DEVELOPMENT OF A DATABASE FOR SPECTRAL DATA AND ANALYSIS RESULTS**
A. D. Dougan, J. B. Carlson, D. R. Manatt, W. M. Buckley, and R. D. Pochy 15 Apr. 1987 5 p Presented at the Ingres User Association Meeting, San Francisco, Calif., 26 Apr. 1987 Prepared in cooperation with Compuchem, Inc., Hayward, Calif.
(Contract W-7405-eng-48)
(DE87-011323; UCRL-96378; CONF-8704121-2) Avail: NTIS HC A02/MF A01

A data-management system to provide quick access to spectral data and to track chemical parameters and analysis results has been developed. Data are collected at workstations which control stand-alone pulse height analyzers used for gamma, X-ray or alpha

counting. The data is electronically transferred to a VAX computer where it is entered into an INGRES database. A set of tools has been developed to allow users easy access to this database. Intergroup transfer of analyzed results is in the form of transactions, which are modeled after banking transactions. DOE

**N88-11565#** Sandia National Labs., Albuquerque, N. Mex.
**FOREIGN LANGUAGE IDENTIFICATION: FIRST STEP IN THE TRANSLATION PROCESS**
Patricia Newman 1987 9 p Presented at the Conference of American Translators Association, Albuquerque, N. Mex., 7 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011065; SAND-87-1557C; CONF-871087-2) Avail: NTIS HC A02/MF A01

Guidelines are given for identifying 16 European languages that use the Latin alphabet by means of the diacritical marks used with particular letters. It is not necessary to know the languages to identify them. Five Slavic languages can be identified on the basis of the Cyrillic letters they use or do not use. Guidelines are also given for discriminating between Chinese, Japanese and Korean. DOE

**N88-11566#** Sandia National Labs., Albuquerque, N. Mex.
**ERRORS ASSOCIATED WITH RUSSIAN NAME TRANSLITERATION**
Catherine E. Pasterczyk 1987 7 p Presented at the Conference of American Translators Association, Albuquerque, N. Mex., 7 Oct. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011717; SAND-87-1320C; CONF-871087-3) Avail: NTIS HC A02

Works from the Soviet Union form a significant portion of the world's scientific and technical literature. Because information is increasingly being stored in machine-readable form and most western keyboards are unable to accommodate Cyrillic characters, some sort of conversion scheme between the Cyrillic and Roman alphabets is necessitated. Unfortunately, no clear agreement exists in theory or in practice of which scheme would be best, hence a multitude are currently in use. The belief that a one-to-one mapping exists between Russian and English is naive. One can view the transliteration process as movement within a multi-dimensional matrix with the following dimensions: source script, target script, conversion scheme, time, intended usage of conversion, context of word, character to be converted, and where the character appears in the word. Errors can occur along any axis of the matrix and accumulate as movement within the matrix takes place. Error introduction into online databases can be reduced by translating and transliterating only from original language documents and introducing some kind of authority control, automated and/or intellectual. DOE

**N88-11567#** Los Alamos National Lab., N. Mex. Computer Documentation Group.
**ELECTRONIC AUTHORING TOOLS**
Jeanne M. Hurford 1987 4 p Presented at the Institute of Electrical and Electronic Engineers Professional Communication Society Conference, Winnipeg, Manitoba, 14-16 Oct. 1987
(Contract W-7405-eng-36)
(DE87-011797; LA-UR-87-1860; CONF-871086-2) Avail: NTIS HC A02/MF A01

More than a decade ago, word processing software revolutionized the way documents were prepared, and productivity was increased. But the editing and formatting capabilities of most word processors did very little to prevent errors in spelling, typing, grammar, diction, style, or organization from slipping through to the final documents. In the past few years, the number of software tools that aid the author has increased substantially. They now vary in scope from simple spelling checkers to sophisticated diction analyzers and idea processors. Moreover, writing-aid-software described in this report is now available for many types of computing systems, including personal computers, scientific workstations, and mainframes. The various pieces of software can be used in interactive or non-interactive (batch) modes. DOE

**N88-11568#** Oak Ridge National Lab., Tenn.
**KNOWLEDGE ACQUISITION ISSUES ENCOUNTERED DURING THE DEVELOPMENT OF AN ESTIMATING EXPERT SYSTEM**
Kendra Albright, M. L. Emrich, A. Robert Sadlowe, Lloyd Arrowood, and Bradley D. Watson 14 Aug. 1987 14 p Presented at the 2d International Conference on Human-Computer Interaction, Honolulu, Hawaii, 10 Aug. 1987
(Contract DE-AC05-84OR-21400)
(DE87-013320; CONF-870841-3) Avail: NTIS HC A03/MF A01

Artificial Intelligence, in particular expert systems methodologies, is being applied to the US Navy's automated data processing (ADP) project estimating tasks. Skilled Navy project leaders are nearing retirement and replacements may not possess the many years of experience required to make accurate estimating decisions of time, cost, equipment, and personnel needs. Knowledge acquisition has traditionally hindered the building of an expert system. A variety of information gathering techniques is discussed. Methods of interviewing, documenting, and verifying information are described. Project leaders were interviewed to capture their unique estimating expertise. Combining this information revealed fewer redundancies and contradictions than expected. The prototyping of the ADP-Estimator System is presented as part of the knowledge acquisition process. DOE

**N88-11569#** Argonne National Lab., Ill. Mathematics and Computer Science Div.
**MAINTAINING STATE CONSTRAINTS IN RELATIONAL DATABASES: A PROOF THEORETIC BASIS**
W. W. McCune and L. J. Henschen Jun. 1987 27 p
(Contract W-31-109-eng-38)
(DE87-014329; ANL/MCS-TM-94) Avail: NTIS HC A03/MF A01

If a relational database is required to satisfy a set of integrity constraints, then when the database is updated, one must ensure that it continues to satisfy the constraints. It is desirable not to have to evaluate each constraint after each update. A method is described that takes a constraint C and a class of updates, and either proves that an update in the class cannot violate the C, or produces a formula C' (a complete test) that is satisfied before the update if and only if the C would continue to be satisfied were the update to occur. C' is frequently much easier to evaluate than the C. In addition, a formula D (a sufficient test) is sometimes produced such that if D is satisfied before the update, then C would continue to be satisfied were the update to occur. The method is proved correct. The method is substantially more general than other reported techniques for this problem. The method has been implemented, and a number of experiments with the implementation are presented. DOE

**N88-11570#** Oak Ridge National Lab., Tenn.
**DEFINITIONS AS DATABASE RECORDS**
R. A. Strehlow 1987 20 p Presented at the American Society for Testing and Materials, Cincinnati, Ohio, 21 Jun. 1987
(Contract DE-AC05-84OR-21400)
(DE87-014057; CONF-870649-2) Avail: NTIS HC A03/MF A01

New information technology is being applied to the task of terminology management in ASTM. We visualize an enhancement of product quality, a facility to increase the scope of terminology work, an increased selection of products, and the potential for becoming more appropriately involved in international standardization efforts. Considering the feasibility and costs for the options that are just now becoming evident will provide an exciting technical challenge for some time into the future. Choice of direction will be determined in part by results of the competition for resources that are always too limited. However, the possible rewards are great. DOE

**N88-11571#** Center for Social and Economic Issues, Ann Arbor, Mich.
**IMPLEMENTING AND MANAGING CHANGE: A GUIDE FOR ASSESSING INFORMATION TECHNOLOGY**
J. A. Morell, R. Gryder, and M. Fleischer Aug. 1987 100 p
Prepared in cooperation with ORNL, Tenn.
(Contract DE-AC05-84OR-21400)
(DE88-000035; ORNL/TM-10520) Avail: NTIS HC A05/MF A01

Assessing the impact of office automation (OA) requires expertise in the generic aspects of evaluation and innovation adoption, combined with specialized knowledge of OA. There is an extensive literature on the two generic subjects, but no companion literature concerning the application of the knowledge to the unique case of OA. By providing that specialized information, this report assists the implementors of OA in two ways: it shows them how to monitor implementation efforts, thus providing feedback to facilitate adoption of OA technology; and it provides guidance for measuring OA's impact on people and organizations. The report assumes an immediate impact of OA on the work groups where the technology is implemented, and a continually spreading effect from that locus of immediate use. Included in the report are discussions of: sources of data, methods of data collection, factors which affect implementation, and measures of impact. Special attention is given to measuring productivity changes that may result from the use of OA. A detailed appendix supplies a variety of examples which show how the variables discussed in the report were actually measured in applied settings. DOE

# 83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

**N88-11572#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensgruppe Raumfahrt.
**DETERMINATION OF LIFE CYCLE COSTS IN ASTRONAUTICS [ERMITTLUNG VON LEBENSZYKLUSKOSTEN IN DER RAUMFAHRT]**
C. Krummrey and F. Blank 1986 4 p In GERMAN
(MBB-UR-E-910/86-PUB; ETN-87-90577) Avail: NTIS HC A02/MF A01

The possibilities of life cycle cost determination for space projects are discussed. Cost determination methods, based on the work breakdown structure, are presented. The procedure of the parametric cost estimate model is outlined. ESA

# 84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**N88-11573#** General Accounting Office, Washington, D. C. General Government Div.
**FREEDOM OF INFORMATION ACT: FEE WAIVER PRACTICES AT THE FBI (FEDERAL BUREAU OF INVESTIGATION)**
Jun. 1987 24 p
(PB87-216727; GAO/GGD-87-73BR; B-221963) Avail: NTIS HC A03/MF A01 CSCL 05B

The report reviews how the Federal Bureau of Investigation (FBI) administers the provision of the Freedom of Information Act (FOIA) pertaining to the waiver of fees charged on information requests. The objectives of the review at the FBI were to: (1) identify and describe the procedures and standards used in making fee waiver decisions, and (2) provide information on how the procedures and standards were applied to specific fee waiver requests. GRA

# 85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

**N88-11574#** Computer Horizons, Inc., Haddon Heights, N.J.
**IDENTIFYING AREAS OF LEADING EDGE JAPANESE SCIENCE AND TECHNOLOGY: ACTIVITY ANALYSIS USING SIC (STANDARD INDUSTRIAL CLASSES) CATEGORIES AND SCIENTIFIC SUBFIELDS Interim Technical Report No. 1, 1975 - 1984**
F. Narin and D. Olivastro 19 May 1986 96 p
(Grant NSF SRS-85-07306)
(PB87-204087) Avail: NTIS HC A05/MF A01 CSCL 05A

The growth of Japanese patenting is particularly apparent with the Japanese invented U.S. patents increasing from approx. 8.8 percent in 1975 to 16.5 percent of U.S. patents in 1984. In scientific papers the Japanese increased from approx. 5.1 percent in 1973 to 7.3 percent in 1982. The broad areas of emphasis of the two countries are also shown to be in strong contrast. In science the Japanese show a particularly emphasis in chemistry and physics with an average emphasis in bioscience. In contrast the U.S. shows emphasis in earth and space science, and notable emphasis in the biomedical fields of clinical medicine and biomedical research. Field by field Japanese and U.S. science activity correlate at 0.90, almost total opposites. In technology also there are sharp contrast, with Japanese activity notably high in various areas related to electronics, automotive, photography, scientific instrumentation and office computing. These areas of high Japanese activity are also areas in which they have increased their activity over the last ten years: in fact, the Japanese have increased their share in 40 of the 42 different product fields. GRA

**N88-11575#** Computer Horizons, Inc., Haddon Heights, N.J.
**IDENTIFYING AREAS OF LEADING EDGE JAPANESE SCIENCE AND TECHNOLOGY: PATENT ACTIVITY AND CITATION ANALYSIS USING US POC (PATENT OFFICE CLASSIFICATION) CLASSIFICATION Interim Technical Report No. 2, 1975 - 1984**
F. Narin and D. Olivastro 5 Sep. 1986 72 p
(Grant NSF SRS-85-07306)
(PB87-204095) Avail: NTIS HC A04/MF A01 CSCL 05A

Analysis of Japanese invented patents appearing in the U.S. patent system over the 10 yr period 1975 to 1984, shows that the share of U.S. patents with Japanese inventors increased from 8.8 percent of all U.S. patents in 1975 to 16.5 percent in 1984, while the share of patents with U.S. inventors decreased from 64.9 to 57.1 percent. Japanese inventors obtained 8 percent more U.S. patents while U.S. inventors obtained 8 percent fewer, and the rest of the world's inventors remained approx. constant. In the U.S. patent system, the increase in Japanese share was entirely at the expense of the U.S. The Japanese patents are shown to be quite concentrated in relatively high technology classes related to those areas of consumer products where there is a major Japanese presence, including electronics, photography, and automotive technology. There is also a growing Japanese presence in the pharmaceutical area. When looked at from the point of view of citation analysis, that is considering highly cited patents to be patents of particular technical impact and quality, the Japanese performance is just as impressive. The Japanese position in patented technology appears to be strong, growing and based on high quality. GRA

**N88-11576#** Pacific Northwest Labs., Richland, Wash.
**ASSESSMENT OF THE IMPACTS OF TRANSFERRING CERTAIN NUCLEAR REACTOR TECHNOLOGIES TO THE SOVIET UNION AND EASTERN EUROPE**
J. W. Upton, Jr. Jun. 1987 73 p
(Contract DE-AC06-76RL-01830)
(DE87-014388; PNL-X-765) Avail: NTIS HC A04/MF A01

The Office of International Security Affairs of the US Department of Energy (DOE) has asked Pacific Northwest Laboratory (PNL) researchers to evaluate the impact that transfer of specific nuclear reactor technologies may have on US national security interests. The evaluation is to be used as a technical basis and guideline to approve or disapprove requests from government and industry to transfer a specific technology to Soviet Bloc countries. The US Government has a responsibility to review such requests. For the post-Chernobyl information-gathering and dissemination process, DOE is the US Government's point of contact with industry. It is DOE's policy to encourage and assist the Eastern Bloc countries to enhance the safety, reliability, and safe operation of civil nuclear reactor power plant facilities worldwide consistent with US national security and nonproliferation interests. Requests from industry for nuclear reactor technology, equipment, and services will be considered in accordance with existing nuclear export policy, law, and regulations. All requests and proposals are to be reviewed on a case-by-case basis. This initial report is to updated periodically. DOE

**N88-11577*#** National Aeronautics and Space Administration, Washington, D.C.
**SPINOFF, 1987**
Aug. 1987 134 p
(NASA-TM-89652; NAS 1.15:89652) Avail: SOD HC $7.00 as 033-000-01008-7; NTIS MF A01 CSCL 05B

Various current or forthcoming NASA projects and experiments with potential for technology spinoff are described. NASA technological advances with existing commercial applications are outlined in the following areas: transportation; consumer; home; and recreation; medicine; resources management; energy; public safety; and manufacturing technology and industrial productivity. Specific systems, devices, and equipment are described. A concluding essay describes the NASA technology utilization/transfer effort. J.P.B.

**N88-11578*#** Mechanical Technology, Inc., Latham, N. Y.
**AUTOMOTIVE STIRLING ENGINE: MOD 2 DESIGN REPORT Final Report**
Noel P. Nightingale Oct. 1986 56 p
(Contracts DEN3-32; DE-AI01-85CE-50112)
(NASA-CR-175106; DOE/NASA/0032-28; NAS 1.26:175106; MT186ASE58SRI) Avail: NTIS HC A04/MF A01 CSCL 13F

The design of an automotive Stirling engine that achieves the superior fuel economy potential of the Stirling cycle is described. As the culmination of a 9-yr development program, this engine, designated the Mod 2, also nullifies arguments that Stirling engines are heavy, expensive, unreliable, demonstrating poor performance. Installed in a General Motors Chevrolet Celebrity car, this engine has a predicted combined fuel economy on unleaded gasoline of 17.5 km/l (41 mpg)- a value 50% above the current vehicle fleet average. The Mod 2 Stirling engine is a four-cylinder V-drive design with a single crankshaft. The engine is also equipped with all the controls and auxiliaries necessary for automotive operation. Author

# 88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

# 89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

**N88-11579*#** Pennsylvania State Univ., University Park. Dept. of Astronomy.
**SOFT X-RAY OBSERVATIONS OF PRE-MAIN SEQUENCE STARS IN THE CHAMAELEON DARK CLOUD**
Eric D. Feigelson and Gerard A. Kriss (Johns Hopkins Univ., Baltimore, Md.) 30 Sep. 1987 46 p
(Grant NAG8-607)
(NASA-CR-181457; NAS 1.26:181457) Avail: NTIS HC A03/MF A01 CSCL 03A

Einstein IPC observations of the nearby Chamaeleon I star forming cloud show 22 well-resolved soft X-ray sources in a 1x2 deg region. Twelve are associated with H-alpha emission line pre-main sequence (PMS) stars, and four with optically selected PMS stars. Several X-ray sources have two or more PMS stars in their error circles. Optical spectra were obtained at CTIO of possible stellar counterparts of the remaining X-ray sources. They reveal 5 probable new cloud members, K7-MO stars with weak or absent emission lines. These naked X-ray selected PMS stars are similar to those found in the Taurus-Auriga cloud. The spatial distributions and H-R diagrams of the X-ray and optically selected PMS stars in the cloud are very similar. Luminosity functions indicate the Chamaeleon stars are on average approximately 5 times more X-ray luminous than Pleiad dwarfs. A significant correlation between L sub x and optical magnitude suggests this trend may continue within the PMS phase of stellar evolution. The relation of increasing X-ray luminosity with decreasing stellar ages is thus extended to stellar ages as young as 1 million years. Author

**N88-11580** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fur Extraterrestrische Physik.
**ULTRAVIOLET OBSERVATIONS OF CATACLYSMIC VARIABLES: THE IUE ARCHIVE**
Frank Verbunt Jul. 1987 45 p Submitted for publication
(MPE-Preprint-91; ISSN-0178-0719; ETN-87-91036) Copyright Avail: Fachinformationszentrum, Karlsruhe, Fed. Republic of Germany

The reddening of 51 cataclysmic variable to 51 systems is determined from the 2200 A feature. Spectral flux distribution does not depend on system type, orbital period or (for dwarf novae) average length of interval between outburst maxima; it does not depend strongly on inclination, except in DQ Her systems, which may have relatively low fluxes at short wavelengths as compared to the other systems. All systems show variability on a time scale of hours. In two nova-like variables in a low state and in five dwarf novae in quiescence there is evidence that most of the ultraviolet flux at short wavelengths is due to the white dwarf. Disk model spectra are calculated to show that the slope of the spectrum depends strongly on the white dwarf mass. Hence determinations of the mass transfer rate from the spectral slope are subject to large errors in cases where the white dwarf mass is not known. ESA

**N88-11581** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fuer Extraterrestrische Physik.
**ULTRAVIOLET OBSERVATIONS OF AM HER**
John Heise (Space Research Organization Netherlands, Utrecht.) and Frank Verbunt Jul. 1987 19 p Submitted for publication Sponsored by DOE
(MPE-Preprint-92; ISSN-0178-0719; ETN-87-91037) Copyright Avail: Fachinformationszentrum, Karlsruhe, Fed. Republic of Germany

Observations of AM Her at different flux levels were obtained with the IUE. Observations obtained at the lowest flux level suggest an upper limit to the white dwarf temperature of 20,000 K, confirming a temperature determination by Schmidt et al. (1981) from optical spectrophotometry. The increased flux levels at other times are due to moderate heating of a large fraction of the white dwarf surface rather than to strong heating of small areas around the accretion poles. Comparison with soft X-ray observations shows

that the orbital maximum of the soft-X-ray light curve sometimes (during the reversed on state) occurs during the minimum of the ultraviolet light curve. This shows that straightforward interpretation of the varying component of the ultraviolet flux as the tail of black-body soft X-ray flux is not correct. ESA

**N88-11582** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fuer Extraterrestrische Physik.
**THE HARD X-RAY ECLIPSE IN THE INTERMEDIATE POLAR EX HYDRAE**
K. Beuermann and J. P. Osborne (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ) Jul. 1987 13 p Submitted for publication
(MPE-Preprint-95; ETN-87-91040) Copyright Avail: Fachinformationszentrum, Karlsruhe, Fed. Republic of Germany

The partial hard X-ray eclipse in EX Hydrae is shown to vary in depth with the 67 min rotation period of the accreting magnetic white dwarf and with photon energy. The eclipse is deeper at 67 min maximum than at minimum reaching the same residual flux in both cases. Averaged over 67 min phase, the fractional eclipse depths are 31 and 42 percent in the 1.6 to 3.6 ke V and 3.6 to 7.4 ke V range, respectively. It is suggested that X-ray emission is observed from both poles of the white dwarf and that the partial eclipse is due to the lower pole being eclipsed while the upper escapes eclipse. ESA

**N88-10830*#** Centre National d'Etudes Spatiales, Toulouse (France).
**INFRA-RED LAMP PANEL STUDY AND ASSESSMENT APPLICATION TO THERMAL VACUUM TESTING OF SIGMA TELESCOPE**
Jacques Mauduyt, Joseph Merlet, and Christiane Poux (Intespace, Toulouse, France ) *In* NASA- Goddard Space Flight Center, Greenbelt, Md. Fourteenth Space Simulation Conference: Testing for a Permanent Presence in Space 1986 p 1-14 (For primary document see N88-10829 02-18)
Avail: NTIS HC A19/MF A01 CSCL 03A

**N88-11594*#** Observatoire de Toulouse (France).
**SPECTROSCOPY AND NONTHERMAL PROCESSES**
Monique Querci *In* NASA, Washington, The M-Type Stars 1987 p 113-207 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03A

**N88-11624*#** National Solar Observatory, Sunspot, N. Mex. National Optical Astronomy Observatories.
**IMAGING INTERFEROMETRY WITH NON-REDUNDANT ARRAYS**
J. B. Zirker *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 143-144 Sponsored by NSF (For primary document see N88-11609 02-92)
Avail: NTIS HC A07/MF A01 CSCL 03A

# 90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics*.

**N88-11583#** Lawrence Livermore National Lab., Calif.
**INSTITUTE OF GEOPHYSICS AND PLANETARY PHYSICS AT LAWRENCE LIVERMORE NATIONAL LABORATORY Annual Report, 1986**
C. E. Max, ed. 1 Jul. 1987 92 p
(Contract W-7405-eng-48)
(DE87-014618; UCRL-53809) Avail: NTIS HC A05/MF A01

The purpose of the Institute of Geophysics and Planetary Physics (IGPP) at LLNL is to enrich the opportunities of University of California campus researchers by making available to them some of the Laboratory's unique facilities and expertise, and to broaden the scientific horizon of LLNL researchers by encouraging collaborative or interdisciplinary work with other UC scientists. The IGPP continues to emphasize three fields of research - geoscience, astrophysics, and high-pressure physics - each administered by a corresponding IGPP Research Center. Each Research Center coordinates the mini-grant work in its field, and also works with the appropriate LLNL programs and departments, which frequently can provide supplementary funding and facilities for IGPP projects. DOE

**N88-11584#** Los Alamos National Lab., N. Mex.
**HIGH EXPLOSIVE SIMULATIONS OF SUPERNOVAE AND THE SUPERNOVA SHELL FRAGMENTATION MODEL OF SOLAR SYSTEM FORMATION**
W. K. Brown Sep. 1987 11 p
(Contract W-7405-eng-36)
(DE87-014708; LA-11005) Avail: NTIS HC A03/MF A01

Comparison of photographs of explosive experiments to the Casseopeia A supernova remnant reveals a striking similarity. The similarity could indicate the presence of a relatively cool, underlying shell in the Casseopeia A remnant. As this shell expands and fragments, the observable features are produced by hot gases squirting through the cracks - as in explosive experiments. The existence of such underlying shells in supernova remnants supports the author's model of solar system formation. DOE

**N88-11585#** International Centre for Theoretical Physics, Trieste (Italy).
**OUR UNIVERSE AS AN ATTRACTOR IN A SUPERSTRING MODEL**
Keiichi Maeda Nov. 1986 18 p
(DE87-703066; IC-86/315) Avail: NTIS (US Sales Only) HC A03/MF A01

One preferential scenario of the evolution of the universe is discussed in a superstring model. The universe can reach the present state as an attractor in the dynamical system. The kinetic terms of the axions play an important role so that our present universe is realized almost uniquely. DOE

**N88-11586#** International Centre for Theoretical Physics, Trieste (Italy).
**ON THE DEGREE OF GENERALITY OF INFLATIONARY SOLUTIONS IN COSMOLOGICAL MODELS WITH A SCALAR FIELD**
V. A. Belinsky and I. M. Khalatnikov Nov. 1986 32 p
(DE87-703079; IC-86/355) Avail: NTIS (US Sales Only) HC A03/MF A01

Homogeneous cosmological models of Bianchi I and Friedmann type in the presence of the massive scalar field are studied. Using qualitative theory of dynamical systems we show that the majority of solutions undergoes the inflationary stage. This study is the direct continuation of a previous paper. DOE

**N88-11587#** International Centre for Theoretical Physics, Trieste (Italy).
**CRUCIAL COSMOLOGICAL OBSERVATIONS**
V. N. Lukash and I. D. Novikov Nov. 1986 15 p
(DE87-703081; IC-86/357) Avail: NTIS (US Sales Only) HC A03/MF A01

A current problem of determining the fundamental constants of the Universe - H sub O, q sub O, omega, lambda, hidden matter and primordial perturbation parameters - is considered. New evidence for the large-scale T/T-fluctuations to be found in the near future are discussed. DOE

**N88-11588#** International Centre for Theoretical Physics, Trieste (Italy).
**GEOMETRIZATION OF PLANCK LENGTH IN COMPOSITE GRAVITY AND SUPERGRAVITY**
J. Lukierski, M. Mozrzymas, and L. Rytel Nov. 1986 9 p
(DE87-703085; IC-86/366) Avail: NTIS (US Sales Only) HC A02/MF A01

The Volkov-Akulov (VA) standard action can be treated as composite cosmological term, with composite vierbein described by massless Goldstone fermions. By considering massive Goldstone fermions one can relate classically VA and composite Einstein gravity actions, provided the mass of Goldstone fermions, Planck mass and the SSB scale are related. It is also shown that the action of N=1 and N=2 supergravity with composite gauge fields can be written respectively module topological terms as N=1 and N=2 composite supersymmetric cosmological terms. DOE

**N88-11589#** International Centre for Theoretical Physics, Trieste (Italy).
**MIGHT DARK MATTER NOT BE CONCENTRIC WITH LUMINOUS MATTER**
Chongming Xu and Tan Lu Dec. 1986 11 p
(DE87-703094; IC-86/391) Avail: NTIS (US Sales Only) HC A03/MF A01

In this paper, an idea on dark matter nonconcentric with luminous matter is proposed. This case could influence the rotation curve of galaxy differently in its different direction. Recently, Rubin and Ford's observation on rotation curve of Hickson 88a has been explained by means of the idea. Some possible observational predictions have also been given. DOE

**N88-11590#** Hiroshima Univ. (Japan). Research Inst. for Theoretical Physics.
**MAGNITUDE-REDSHIFT RELATION IN A PERTURBED FRIEDMANN UNIVERSE**
Misao Sasaki Feb. 1987 32 p
(DE87-753020; RRK-87-1) Avail: NTIS (US Sales Only) HC A03/MF A01

A general formula for the magnitude-redshift relation in a linearly perturbed Friedmann universe is derived. The formula does not assume any specific gauge condition, but the gauge-invariance of it is explicitly shown. Then the application of the formula to the spatially flat background model is considered and the implications are discussed. DOE

**N88-11591#** Hiroshima Univ. (Japan). Research Inst. for Theoretical Physics.
**CHIRAL U(1) ANOMALY IN D = 4 SUPER YANG-MILLS THEORY COUPLED TO SUPERGRAVITY**
Yoshinori Nagahama, Syuichi Ojima, Kenji Sakai, and Masaru Takao Mar. 1987 8 p
(DE87-753022; RRK-87-6) Avail: NTIS (US Sales Only) HC A02/MF A01

We evaluate the chiral U(1) anomaly in D = 4 supersymmetric Yang-Mills theory coupled to supergravity. We consider not only the minimal coupling between the gauge fields and fermions but also the interaction term which mixes gravitino and gaugino. We show that the mixing interaction gives the new contributions to the anomaly. This fact suggests necessity for reexamination of the Green-Schwarz anomaly cancellation mechanism. DOE

**N88-11592*#** National Aeronautics and Space Administration, Washington, D.C.
**THE M-TYPE STARS**
Hollis Ralph Johnson, Francois R. Querci, Stuart Jordan, ed., Richard Thomas, ed., Leo Goldberg (Kitt Peak National Observatory, Tucson, Ariz.), and Jean-Claude Pecker 1987 576 p Prepared in cooperation with CNRS, Paris, France Its Monograph Series on Nonthermal Phenomena in Stellar Atmospheres, Volume 5
(NASA-SP-492; NAS 1.21:492; LC-87-11340) Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

The papers in this volume cover the following topics: (1) basic properties and photometric variability of M and related stars; (2) spectroscopy and nonthermal processes; (3) circumstellar radio molecular lines; (4) circumstellar shells, the formation of grains, and radiation transfer; (5) mass loss; (6) circumstellar chemistry; (7) thermal atmospheric models; (8) quasi-thermal models; (9) observations on the atmospheres of M dwarfs; and (1) theoretical work on M dwarfs. For individual titles, see N88-11593 through N88-11602.

**N88-11593*#** Observatoire de Toulouse (France).
**BASIC PROPERTIES AND VARIABILITY**
Francois R. Querci *In* NASA, Washington, The M-Type Stars 1987 p 1-112 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

Giant and supergiant M, S, and C stars are discussed in this survey of research. Basic properties as determined by spectra, chemical composition, photometry, or variability type are discussed. Space motions and space distributions of cool giants are described. Distribution of these stars in our galaxy and those nearby is discussed. Mira variables in particular are surveyed with emphasis on the following topics: (1) phase lag phenomenon; (2) Mira light curves; (3) variations in color indices; (4) determination of multiple periods; (5) correlations between quantities such as period length, light-curve shape, infrared (IR) excess, and visible and IR color diagram; (6) semiregular (SR) variables and different time scales in SR light variations; (7) irregular variable Lb and Lc stars; (8) different time-scale light variations; (9) hydrogen-deficient carbon (HdC) stars, in particular RCB stars; and (10) irreversible changes and rapid evolution in red variable stars. J.P.B.

**N88-11594*#** Observatoire de Toulouse (France).
**SPECTROSCOPY AND NONTHERMAL PROCESSES** **c89**
Monique Querci *In* NASA, Washington, The M-Type Stars 1987 p 113-207 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03A

Stellar spectra are analyzed to determine nonthermal processes for cool stars. A shock wave crossing model is supported by a study of the behavior of absorption and emission spectra. The shock waves are attributed to atmospheric kinetics. Circumstellar spectral lines are studied for information about gaseous circumstellar layers. The description of stellar envelopes is carried on through circumstellar dust. Characteristic properties of polarization in the dust are described in the case of specific stars, emphasizing narrowband observations in Mira, semiregular, and supergiant stars. Finally, the direct approach to measuring the angular diameters of stars and mapping the distribution of circumstellar dust and gas by lunar occultation or interferometry is discussed, using two prototype stars, an M supergiant and a dusty carbon star. J.P.B.

**N88-11595*#** Observatoire de Paris-Meudon (France). Section d'Astrophysique.
**CIRCUMSTELLAR RADIO MOLECULAR LINES** **c93**
Nguyen-Quang-Rieu *In* NASA, Washington, The M-Type Stars 1987 p 209-224 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

Radio molecular lines appear to be useful probes into the stellar environment. Silicon oxide masers provide information on the physical conditions in the immediate vicinity of the stellar photosphere. Valuable information on the physics operating in the envelope of IRC + 10216 was recently obtained by high sensitivity observations and detailed theoretical analyses. Infrared speckle interferometry in the molecular lines and in the continuum is helpful in the investigation of the inner region of the envelope. These techniques are discussed in terms of late-type star mass loss. B.G.

**N88-11596*#** Observatoire du Mont-Gros, Nice (France).
**CIRCUMSTELLAR SHELLS, THE FORMATION OF GRAINS, AND RADIATION TRANSFER**
Jean LeFevre *In* NASA, Washington, The M-Type Stars 1987 p 225-244 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

Advances in infrared astronomy during the last decade have firmly established the presence of dust around a large number of

cold giant and supergiant stars. To describe the properties of stars and to understand their evolution, it is necessary to know the nature of the giants and their influence on stellar radiation. Two questions are considered: the formation of grains around cold stars and the modification of stellar radiation by the stellar shell. Author

**N88-11597*#** Kitt Peak National Observatory, Tucson, Ariz.
**MASS LOSS**
Leo Goldberg *In* NASA, Washington, The M-Type Stars 1987 p 245-289 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

Observational evidence for mass loss from cool stars is reviewed. Spectra line profiles are used for the derivation of mass-loss rates with the aid of the equation of continuity. This equation implies steady mass loss with spherical symmetry. Data from binary stars, Mira variables, and red giants in globular clusters are examined. Silicate emission is discussed as a useful indicator of mass loss in the middle infrared spectra. The use of thermal millimeter-wave radiation, Very Large Array (VLA) measurement of radio emission, and OH/IR masers are discussed as a tool for mass loss measurement. Evidence for nonsteady mass loss is also reviewed. B.G.

**N88-11598*#** New York Univ., New York. Dept. of Physics.
**CIRCUMSTELLAR CHEMISTRY**
Alfred E. Glassgold and Patrick J. Huggins *In* NASA, Washington, The M-Type Stars 1987 p 291-322 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

The study of the outer envelopes of cool evolved stars has become an active area of research. The physical properties of CS envelopes are presented. Observations of many wavelengths bands are relevant. A summary of observations and a discussion of theoretical considerations concerning the chemistry are summarized. Recent theoretical considerations show that the thermal equilibrium model is of limited use for understanding the chemistry of the outer CS envelopes. The theoretical modeling of the chemistry of CS envelopes provides a quantitive test of chemical concepts which have a broader interest than the envelopes themselves. B.G.

**N88-11599*#** Indiana Univ., Bloomington. Dept. of Astronomy.
**THERMAL ATMOSPHERIC MODELS**
Hollis Ralph Johnson *In* NASA, Washington, The M-Type Stars 1987 p 323-371 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

The static thermal atmosphere is described and its predictions are compared to observations both to test the validity of the classic assumptions and to distinguish and describe those spectral features with diagnostic value. B.G.

**N88-11600*#** Instituto de Pesquisas Espaciais, Rio de Janeiro (Brazil). Conselho Nacional de Desenvolvimento Cientifico e Technologico.
**QUASI-THERMAL MODELS**
Ramiro delaReza *In* NASA, Washington, The M-Type Stars 1987 p 373-408 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

Non-local thermodynamics equilibrium (LTE) effects in the photosphere; recent research on the chromosphere of the M and C stars; and elementary shock-waves and pulsation theories and their applications to Mira long-period variables are discussed. B.G.

**N88-11601*#** Catania Univ. (Italy). Inst. di Astronomia.
**THE ATMOSPHERES OF M DWARFS: OBSERVATIONS**
Marcello Rodono *In* NASA, Washington, The M-Type Stars 1987 p 409-453 Sponsored by Ministero della Pubblica Istruzione and CNR (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

After presenting global properties of M dwarfs, the principal diagnostic of activity phenomena occurring in their atmosphere from the geometrical, energetic, and temporal points of view is stressed. Observations of sunspots, plages, flares, and activity cycles are presented. The major sources of activity are discussed with particular emphasis on the generation, intensification, and measurements of stellar magnetic fields. B.G.

**N88-11602*#** Delaware Univ., Newark. Bartol Research Foundation.
**M DWARFS: THEORETICAL WORK**
Dermott J. Mullan *In* NASA, Washington, The M-Type Stars 1987 p 455-479 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

Theoretical work on the atmospheres of M dwarfs has progressed along lines parallel to those followed in the study of other classes of stars. Such models have become increasingly sophisticated as improvements in opacities, in the equation of state, and in the treatment of convection were incorporated during the last 15 to 20 years. As a result, spectrophotometric data on M dwarfs can now be fitted rather well by current models. The various attempts at modeling M dwarf photospheres in purely thermal terms are summarized. Some extensions of these models to include the effects of microturbulence and magnetic inhomogeneities are presented. B.G.

**N88-11603*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**COMPOSITION, STRUCTURE AND CHEMISTRY OF INTERSTELLAR DUST**
A. G. G. M. Tielens and L. J. Allamandola (California Univ., Berkeley.) Sep. 1986 76 p
(NASA-TM-88350; A-86383; NAS 1.15:88350) Avail: NTIS HC A05/MF A01 CSCL 03B

The observational constraints on the composition of the interstellar dust are analyzed. The dust in the diffuse interstellar medium consists of a mixture of stardust (amorphous silicates, amorphous carbon, polycyclic aromatic hydrocarbons, and graphite) and interstellar medium dust (organic refractory material). Stardust seems to dominate in the local diffuse interstellar medium. Inside molecular clouds, however, icy grain mantles are also important. The structural differences between crystalline and amorphous materials, which lead to differences in the optical properties, are discussed. The astrophysical consequences are briefly examined. The physical principles of grain surface chemistry are discussed and applied to the formation of molecular hydrogen and icy grain mantles inside dense molecular clouds. Transformation of these icy grain mantles into the organic refractory dust component observed in the diffuse interstellar medium requires ultraviolet sources inside molecular clouds as well as radical diffusion promoted by transient heating of the mantle. The latter process also returns a considerable fraction of the molecules in the grain mantle to the gas phase. Author

**N88-11615*#** Chicago Univ., Ill.
**SMALL-SCALE ENERGY STORAGE AND RELEASE AS THE CAUSE OF THE STELLAR X-RAY CORONA**
E. N. Parker *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 89-99 (For primary document see N88-11609 02-92)
(Grant NGL-14-001-001)
Avail: NTIS HC A07/MF A01 CSCL 03B

# 91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**N88-11604#** Sandia National Labs., Albuquerque, N. Mex.
**SHOCK-CHEMISTRY IN NATURAL MATERIALS AND EVOLUTION OF PLANETARY SURFACES**
Mark B. Boslough, Randall T. Cygan, Eugene L. Venturini, Bruno Morosin, and Donald L. Williamson (Colorado School of Mines, Golden.) 1987 14 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012737; SAND-87-0954C; CONF-870753-27) Avail: NTIS HC A03/MF A01

There are two possible types of chemical reactions that can take place due to shock-loading of a mineral. The first type is one that takes place on a longer time scale than the shock event, and is due to shock activation of the mineral, i.e., the increase in specific free energy due to increased densities of defects and dislocations. An example of this type was experimentally studied by measuring shock-enhanced dissolution rates of three silicate minerals. The second type is the reaction that occurs immediately, or upon release to ambient pressure, and is due to the large increase in internal energy provided by the shock, together with the shift in chemical equilibrium brought about by the increased pressure and temperature. The clay mineral nontronite was the subject of an experimental study of such reactions. Both processes can affect planetary surfaces, either independently or together. The two processes, acting in synergy, are invoked to explain the composition, mineralogy, color, and physical properties of the Martian soil. DOE

**N88-11605*#** Oregon State Univ., Corvallis.
**POSSIBLE DYNAMICAL MECHANISMS FOR THE MARTIAN POLAR WARMING PHENOMENON Final Report, 1 Apr. 1985 - 30 Sep. 1987**
Jeffrey R. Barnes 1987 9 p
(Grant NAGw-727)
(NASA-CR-181454; NAS 1.26:181454) Avail: NTIS HC A02/MF A01 CSCL 03B

The research performed under NASA contract NAGW-727 falls into three major categories, i.e., dynamical modeling of the Martian polar warming phenomenon, studies of dust and water transport associated with a Martian polar warming, and studies of the possible effects of breaking gravity waves on the Martian atmospheric circulation. The work carried out in each of these areas is summarized. Author

**N88-11606*#** Georgia Inst. of Tech., Atlanta. School of Electrical Engineering.
**LABORATORY EVALUATION AND APPLICATION OF MICROWAVE ABSORPTION PROPERTIES UNDER SIMULATED CONDITIONS FOR PLANETARY ATMOSPHERES Annual Status Report and Semiannual Status Report No. 8, 1 Feb. 1987 - 31 Jan. 1988**
Paul G. Steffes 17 Nov. 1987 51 p
(Grant NAGw-533)
(NASA-CR-181466; NAS 1.26:181466) Avail: NTIS HC A04/MF A01 CSCL 03B

Radio absorptivity data for planetary atmospheres obtained from spacecraft radio occultation experiments and Earth-based radio astronomical observations can be used to infer abundances of microwave absorbing atmospheric constituents in those atmospheres, as long as reliable information regarding the microwave absorping properties of potential constituents is available. The use of theoretically derived microwave absorption properties for such atmospheric constituents, or laboratory measurements of such properties under environmental conditions which are significantly different than those of the planetary atmosphere being studied, often leads to significant misinterpretation of available opacity data. Laboratory measurement of the microwave properties of atmospheric gases under simulated conditions for the outer planets were conducted. Results of these measurements are discussed. E.R.

**N88-11607*#** National Aeronautics and Space Administration, Washington, D.C.
**DIKE ZONES ON VENUS**
M. S. Markov and A. L. Sukhanov Nov. 1987 9 p Transl. into ENGLISH from Doklady Akademii Nauk SSSR (USSR), v. 292, no. 1, 1987 p 172-175 Original language translation was announced in IAA as A87-31975 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-4005)
(NASA-TT-20111; NAS 1.77:20111) Avail: NTIS HC A02/MF A01 CSCL 03B

Venusian dike zone structures were identified from Venera 15 and 16 radar images. These include: a zone of subparallel rows centered at 30 deg N, 7 deg E; a system of intersecting bands centered at 67 deg N, 284 deg E; polygonal systems in lavas covering the structural base uplift centered at 47 deg N, 200 deg E; a system of light bands in the region of the ring structure centered at 43 deg N, 13 deg E; and a dike band centered at 27 deg N, 36 deg E. Author

**N88-11608*#** National Aeronautics and Space Administration, Washington, D.C.
**PRELIMINARY ESTIMATION OF COLAR INHOMOGENEITIES ON THE SURFACE OF VENUS ACCORDING TO THE TELEVISION IMAGES OBTAINED BY THE VENERA-13 AND VENERA-14 AUTOMATED SPACE PROBES**
Yu. G. Shkuratov, M. A. Kreslavskiy, and A. T. Bazilevskiy Nov. 1987 9 p Transl. into ENGLISH from Pisma v Astronomicheskiy Zhurnal (Moscow, USSR), v. 12, no. 10, 1986 p 795-800 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-4005)
(NASA-TT-20114; NAS 1.77:20114) Avail: NTIS HC A02/MF A01 CSCL 03B

Digital processing of images obtained by the Venera 13 and Venera 14 probes led to the discovery of faint color differences of some areas of the observed surface. Maximum color differences were observed in the right part of 14-1 panorama. Color anomaly is associated with the bedrock outcrop having slightly higher albedo than the surrounding. Possible causes of the discovered color differences are discussed. Author

# 92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.
For related information see *93 Space Radiation.*

**N88-11609*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**THEORETICAL PROBLEMS IN HIGH RESOLUTION SOLAR PHYSICS, 2**
G. Athay, ed. (National Center for Atmospheric Research, Boulder, Colo.) and D. S. Spicer, ed. Sep. 1987 141 p Workshop held in Boulder, Colo., 15-17 Sep. 1986
(NASA-CP-2483; Rept-87B0401; NAS 1.55:2483) Avail: NTIS HC A07/MF A01 CSCL 03B

The Science Working Group for the High Resolution Solar Observatory (HRSO) laid plans beginning in 1984 for a series of workshops designed to stimulate a broadbased input from the scientific community to the HRSO mission. These workshops have the dual objectives of encouraging an early start on the difficult theoretical problems in radiative transfer, magnetohydrodynamics, and plasma physics that will be posed by the HRSO data, and maintaining current discussions of results in high resolution solar studies. This workshop was the second in the series. The workshop format presented invited review papers during the formal sessions

and contributed poster papers for discussions during open periods. Both are presented. For individual titles, see N88-11610 through N88-11624.

**N88-11610*#** National Center for Atmospheric Research, Boulder, Colo. High Altitude Observatory.
**MAGNETIC FIELD MORPHOLOGY IN THE UPPER LAYERS**
V. J. Pizzo *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 1-13 Sponsored by NSF (For primary document see N88-11609 02-92)
Avail: NTIS HC A07/MF A01 CSCL 03B

Some basic properties of emerged magnetic flux concentrations are examined with emphasis on the interplay between the magnetic and thermodynamic structure in the region between the photosphere and the transition zone. The discussion is limited to the gross behavior of those phenomena that may be reasonably regarded as quasi-static, such as the longer-lived sunspots, pores, and some smaller magnetic flux tubes. Substructure and dynamic phenomena are not considered. Author

**N88-11611*#** Cambridge Research and Instrumentation, Inc., Mass.
**ACTIVE REGION FLOWS**
Peter Foukal *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 15-35 (For primary document see N88-11609 02-92)
(Contract NAS5-29349; Grant NSF ATM-8519121)
Avail: NTIS HC A07/MF A01 CSCL 03B

A wide range of observations has shown that active region phenomena in the photospheric, chromospheric and coronal temperature regimes are dynamical in nature. At the photosphere, recent observations of full line profiles place an upper limit of about + or - 20/msec on any downflows at supergranule cell edges. Observations of the full Stokes 5 profiles in the network show no evidence for downflows in magnetic flux tubes. In the area of chromospheric dynamics, several models were put forward recently to reproduce the observed behavior of spicules. However, it is pointed out that these adiabatic models do not include the powerful radiative dissipation which tend to damp out the large amplitude disturbances that produce the spicular acceleration in the models. In the corona, loop flows along field lines clearly transport mass and energy at rates important for the dynamics of these structures. However, advances in understanding the heating and mass balance of the loop structures seem to require new kinds of observations. Some results are presented using a remote sensing diagnostic of the intensity and orientation of macroscopic plasma electric fields predicted by models of reconnective heating and also wave heating. Author

**N88-11612*#** Naval Research Lab., Washington, D.C. Center for Space Research.
**WHAT'S NEEDED IN THE UV AND EUV**
G. A. Doschek *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 37-54 (For primary document see N88-11609 02-92)
Avail: NTIS HC A07/MF A01 CSCL 03B

High spectral and spatial resolution UV and EUV spectroscopy is discussed with emphasis on the spectroscopic observations that are required in order to increase the understanding of the physics of the lower transition region. The properties of the lower transition region are reviewed, and the available lower transition region plasma diagnostics are reviewed for the wavelength range between about 1150 and 2000 A. One important conclusion is that comprehensive spectroscopic coverage over a rather broad temperature range is necessary in order to observe satisfactorily small transition region structures. This is illustrated by two examples from the recent NRL Spacelab 2 HRTS experiment. Author

**N88-11613*#** Lockheed Missiles and Space Co., Palo Alto, Calif.
**FIRST RESULTS ON QUIET AND MAGNETIC GRANULATION FROM SOUP**
A. M. Title, T. D. Tarbell, L. Acton, D. Duncan, S. H. Ferguson, M. Finch, Z. Frank, G. Kelly, R. Lindgren, and M. Morrill et al. *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 55-77 Prepared in cooperation with AFGL, Sunspot, N. Mex., National Solar Observatory, Tucson, Ariz., and National Solar Observatory, Sunspot, N. Mex. (For primary document see N88-11609 02-92)
(Contract NAS8-23805)
Avail: NTIS HC A07/MF A01 CSCL 03B

The flight of Solar Optical Universal Polarimeter (SOUP) on Spacelab 2 allowed the collection of time sequences of diffraction limited (0.5 arc sec) granulation images with excellent pointing (0.003 arc sec) and completely free of the distortion that plagues groundbased images. The p-mode oscillations are clearly seen in the data. Using Fourier transforms in the temporal and spatial domain, it was shown that the p-modes dominate the autocorrelation lifetime in magnetic regions. When these oscillations are removed the autocorrelation lifetime is found to be 500 sec in quiet and 950 sec in magnetic regions. In quiet areas exploding granules are seen to be common. It is speculated that a significant fraction of granule lifetimes are terminated by nearby explosions. Using local correlation tracking techniques it was able to measure horizontal displacements, and thus transverse velocities, in the magnetic field. In quiet sun it is possible to detect both super and mesogranulation. Horizontal velocities are as great as 1000 m/s and the average velocity is 400 m/s. In magnetic regions horizontal velocities are much less, about 100 m/s. Author

**N88-11614*#** California Inst. of Tech., Pasadena. Big Bear Solar Observatory.
**HIGH-RESOLUTION CONTINUUM OBSERVATIONS OF THE SUN**
Harold Zirin *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 79-88 (For primary document see N88-11609 02-92)
Avail: NTIS HC A07/MF A01 CSCL 03B

The aim of the PFI or photometric filtergraph instrument is to observe the Sun in the continuum with as high resolution as possible and utilizing the widest range of wavelengths. Because of financial and political problems the CCD was eliminated so that the highest photometric accuracy is only obtainable by comparison with the CFS images. Presently there is a limitation to wavelengths above 2200 A due to the lack of sensitivity of untreated film below 2200 A. Therefore the experiment at present consists of a film camera with 1000 feet of film and 12 filters. The PFI experiments are outlined using only two cameras. Some further problems of the experiment are addressed. Author

**N88-11615*#** Chicago Univ., Ill.
**SMALL-SCALE ENERGY STORAGE AND RELEASE AS THE CAUSE OF THE STELLAR X-RAY CORONA** c90
E. N. Parker *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 89-99 (For primary document see N88-11609 02-92)
(Grant NGL-14-001-001)
Avail: NTIS HC A07/MF A01 CSCL 03B

It has yet to be established why ordinary stars possess X-ray coronas. Detailed observations of the Sun make it doubtful that the X-ray corona is produced by the dissipation of Alfven waves. The uniform X-ray brightness over all scales from 10,000 to 100,000 km simply does not look like a resonance phenomenon. It is demonstrated that the arbitrary winding patterns introduced into the bipolar magnetic fields of X-ray corona produce discontinuities within the field. It is suggested that the random motions of the footprints of the field cause the accumulation of internal strains in the field, which dissipate through neutral reconnection across the associated discontinuities to provide the primary heat source for the X-ray corona. It is emphasized, however, that the essential high resolution observations of the Sun have yet to be carried out, and until the theory is firmly established for the Sun, it cannot be known how to interpret the X-ray emission of the Sun or of the other stars. Author

**N88-11616*#** Colorado Univ., Boulder. Joint Inst. for Lab. Astrophysics.

**MAGNETIC FIELDS IN THE OVERSHOOT ZONE: THE GREAT ESCAPE**

F. Cattaneo and D. W. Hughes *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 101-104 (For primary document see N88-11609 02-92)

(Contract NAS8-31958; Grants NsG-7511; NAGw-91; NAG5-513)

Avail: NTIS HC A07/MF A01 CSCL 03B

In order that magnetic flux be confined within the solar interior for times comparable to the solar cycle period it has been suggested that the bulk of the solar toroidal field is stored in the convectively stable overshoot region situated beneath the convection zone proper. Such a magnetic field, though, is still buoyant and is therefore subject to Rayleigh-Taylor type instabilities. The model problem of an isolated region of magnetic field embedded in a convectively stable atmosphere is considered. The fully nonlinear evolution of the two dimensional interchange of modes is studied, thereby shedding some light on one of the processes responsible for the escape of flux from the solar interior. Author

**N88-11617*#** National Center for Atmospheric Research, Boulder, Colo. High Altitude Observatory.

**THEORETICAL MODELLING OF THE FINE STRUCTURES IN SUNSPOTS**

Arnab Rai Choudhuri *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 105-106 Sponsored by NSF (For primary document see N88-11609 02-92)

Avail: NTIS HC A07/MF A01 CSCL 03B

Until a decade ago most solar physicists thought of a sunspot as the upper end of a giant flux tube floating vertically. The existence of umbral dots and penumbral grains has been known for several decades. On the basis of available observations, they seem to be regions of photospheric intensity with upflowing gas motion and magnetic fields much weaker than in the surrounding sunspot surface. It has also been suggested that the differences in the appearances of umbral dots and granular cells are caused by the highly nonlinear nature of the convection problem in the presense of strong magnetic fields. The main ideas are presented here without any equations. It can be shown that a pocket of field free gas surrounded by a vertical magnetic field in the presence of gravity takes up the shape of a tapering column ending at a vertex at the top. Some convection is expected to take place in the trapped field free gas, whereas the magnetic field around it makes those regions stable against convection. Eventually the apex of the tapering column reaches the photospheric surface where the bulging of the magnetic field makes the field no longer able to close on the field free gas and trap it underneath.

Author

**N88-11618*#** Indian Inst. of Astrophysics, Bangalore.

**PRESSURE STRUCTURE OF SOLAR CORONAL LOOPS**

V. Krishan *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 107-111 (For primary document see N88-11609 02-92)

Avail: NTIS HC A07/MF A01 CSCL 03B

The steady state pressure structure of a coronal loop is discussed in terms of the MHD global invariants of an incompressible plasma. The steady state is represented by the superposition of two Chandrasekhar-Kendall functions corresponding to (n=m=0) and (n=m=1) modes. The relative contribution of the two modes (epsilon) is found to depend on the surface pressure of the coronal loop which is also the pressure of the external medium. The mixed mode state does not exist for high values of the external pressure because epsilon becomes complex. Author

**N88-11619*#** Naval Research Lab., Washington, D.C. Center for Space Research.

**A NUMERICAL STUDY OF THE THERMAL STABILITY OF SOLAR LOOPS**

J. A. Klimchuk, S. K. Antiochos, and J. T. Mariska *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 113-116 Sponsored by NASA and ONR (For primary document see N88-11609 02-92)

Avail: NTIS HC A07/MF A01 CSCL 03B

An important property of all loops is their thermal stability. If low lying hot loops were thermally unstable, for example, a great majority of the low loops on the Sun might be expected to be cool. How small perturbations evolve in low lying, linearly unstable hot loops was determined and how high lying, linearly stable hot loops respond to large amplitude disturbances such as might be expected on the Sun were examined. Only general descriptions and results are given. Author

**N88-11620*#** Naval Research Lab., Washington, D.C. Center for Space Research.

**SOLAR TRANSITION REGION AND CORONAL RESPONSE TO HEATING RATE PERTURBATIONS**

John T. Mariska *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 117-119 Sponsored by NASA and ONR (For primary document see N88-11609 02-92)

Avail: NTIS HC A07/MF A01 CSCL 03B

The solar transition region is in a dynamic state characterized by impulsively upflowing plasma and continually downflowing plasma. Using numerical simulations, the conjecture that the areas of downflowing plasma are simply the base regions of coronal loops in which the heating rate is gradually decreasing and the areas of upflowing plasma are the base regions of coronal loops in which the heating rate is gradually increasing is examined. The calculations suggest that gradually reducing or increasing the heating in a magnetic flux tube will not result in plasma motions that are similar to those that are observed at high spatial resolution in the UV. Author

**N88-11621*#** National Solar Observatory, Sunspot, N. Mex.

**LARGE-SCALE HORIZONTAL FLOWS FROM SOUP OBSERVATIONS OF SOLAR GRANULATION**

L. J. November, G. W. Simon, T. D. Tarbell, A. M. Title, and S. H. Ferguson (Lockheed Missiles and Space Co., Palo Alto, Calif.) *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 121-127 (For primary document see N88-11609 02-92)

Avail: NTIS HC A07/MF A01 CSCL 03B

Using high resolution time sequence photographs of solar granulation from the SOUP experiment on Spacelab 2, large scale horizontal flows were observed in the solar surface. The measurement method is based upon a local spatial cross correlation analysis. The horizontal motions have amplitudes in the range 300 to 1000 m/s. Radial outflow of granulation from a sunspot penumbra into surrounding photosphere is a striking new discovery. Both the supergranulation pattern and cellular structures having the scale of mesogranulation are seen. The vertical flows that are inferred by continuity of mass from these observed horizontal flows have larger upflow amplitudes in cell centers than downflow amplitudes at cell boundaries. Author

**N88-11622*#** National Solar Observatory, Sunspot, N. Mex. National Optical Astronomy Observatories.

**LOOP INTERACTION IN THE VISIBLE EMISSION CORONA: MORPHOLOGICAL DETAILS**

Raymond N. Smartt and Zhenda Zhang (Nanjing Univ., China ) *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 129-132 Sponsored by NSF (For primary document see N88-11609 02-92)

Avail: NTIS HC A07/MF A01 CSCL 03B

Coronagraph observations of two post flare loop systems, recorded photographically in the emissions of Fe 14 (5303 A) and Fe 10 (6374 A), show occasional enhancements at the intersections of some loops. The brightness of such enhancements in the green line gradually increases to a maximum value several times greater than that of the legs of the loops and then declines with a typical lifetime approx. 30 to 60 min. In red line emission the loop systems are usually very faint, but show the same overall type of enhancement, with a lag in maximum brightness relative to that of the green line approx. 10 min. The electron density, derived from the cooling time, is approx. 10 to the 12th power/cu cm. Author

**N88-11623*#** Lockheed Missiles and Space Co., Palo Alto, Calif.
**SUNSPOT OBSERVATIONS FROM THE SOUP INSTRUMENT ON SPACELAB 2**
R. A. Shine, A. M. Title, T. D. Tarbell, L. Acton, D. Duncan, S. H. Ferguson, M. Finch, Z. Frank, G. Kelly, and R. Lindgren et al. *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 133-141 Prepared in cooperation with AFGL, Sunspot, N. Mex., National Solar Observatory, Tucson, Ariz., and National Solar Observatory, Sunspot, N. Mex. (For primary document see N88-11609 02-92)
(Contract NAS8-32805)
Avail: NTIS HC A07/MF A01 CSCL 03B

A series of white light images obtained by the SOUP instrument on Spacelab 2 of active region 4682 on August 5, 1985 were analyzed in the area containing sunspots. Although the umbra of the spot is underexposed, the film is well exposed in the penumbral regions. These data were digitally processed to remove noise and to separate p-mode oscillations from low velocity material motions. The results of this preliminary investigation include: (1) proper motion measurements of a radial outflow in the photospheric granulation pattern just outside the penumbra; (2) discovery of occasional bright structures (streakers) that appear to be ejected outward from the penumbra; (3) broad dark clouds moving outward in the penumbra in addition to the well known bright penumbral grains moving inward; (4) apparent extensions and contractions of penumbral filaments over the photosphere; and (5) observation of a faint bubble or loop-like structure which seems to expand from two bright penumbral filaments into the photosphere. Author

**N88-11624*#** National Solar Observatory, Sunspot, N. Mex. National Optical Astronomy Observatories.
**IMAGING INTERFEROMETRY WITH NON-REDUNDANT ARRAYS** c89
J. B. Zirker *In* NASA-Goddard Space Flight Center, Theoretical Problems in High Resolution Solar Physics, 2 Sep. 1987 p 143-144 Sponsored by NSF (For primary document see N88-11609 02-92)
Avail: NTIS HC A07/MF A01 CSCL 03A

The performance of a set of nonredundant arrays, that convert an existing telescope to an interferometer, was simulated. Each array is a perforated mask, placed at an image of the objective. Each pair of holes in a mask transmits a unique spatial frequency that is present in the target; hence the term nonredundant. Each mask produces a fringe I(f) in the focal plane that is the product of the Fourier transforms of the object and the optical transfer function S(f). Author

**N88-11625#** Brown Univ., Providence, R. I. Dept. of Physics.
**SUPERFLUID He4 AS A SOLAR NEUTRINO DETECTOR**
R. E. Lanou, H. J. Maris, and G. M. Seidel 1987 8 p Presented at the Telemark 4 Conference on Neutrino Mass and Neutrino Astrophysics, Ashland, Wisc., 16-18 Mar. 1987
(Contract DE-AC02-76ER-03130)
(DE87-014477; DOE/ER-03130/32; CONF-8703121-5; COO-3130TC-32) Avail: NTIS HC A02/MF A01

Neutrinos produced in the sun provide a source of unique value in studying neutrino properties. A severe challenge is presented to find suitable detection techniques over the range of neutrino energies involved in solar processes. In particular those produced in the reaction least sensitive to details of the solar model present the most difficulty. We suggest a new technique which shows promise to overcome these difficulties. It is based upon use of superfluid He-4 as the detecting medium and utilizes unusual kinetics of rotons at low temperatures. DOE

**N88-11626#** National Geophysical Data Center, Boulder, Colo.
**SOLAR-GEOPHYSICAL DATA NUMBER 514, JUNE 1987. PART 1: (PROMPT REPORTS). DATA FOR MAY 1987, APRIL 1987 AND LATE DATA**
Helen E. Coffey, ed. and John A. McKinnon, ed. Jun. 1987 111 p
(Contract N00014-86-F-0049)
(PB87-217261; SGD-514-Pt-1; ISSN-0038-0911; LC-79-640375)
Avail: NTIS HC A06/MF A01 CSCL 03B

Solar-Geophysical data contained include: detailed index for 1986 to 1987; data for May 1987 (advance and worldwide IUWDS alert periods, solar activity indices, solar flares, solar radio emission, and Standford mean solar magnetic field); data for April 1987 (solar active regions, sudden ionospheric disturbances, solar radio spectral observations, cosmic ray measurements by neutron monitor, geomagnetic indices, and radio propagation indices); and late data (solar active regions, Pioneer 12 interplanetary magnetic field magnitudes October 1986, cosmic ray measurements by neutron monitor, and geomagnetic indices). GRA

# 93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

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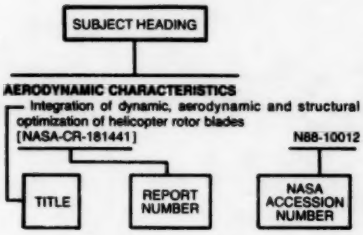
**N88-11595*#** Observatoire de Paris-Meudon (France). Section d'Astrophysique.
**CIRCUMSTELLAR RADIO MOLECULAR LINES**
Nguyen-Quang-Rieu *In* NASA, Washington, The M-Type Stars 1987 p 209-224 (For primary document see N88-11592 02-90)
Avail: SOD HC $26.00 as 033-000-01007-9; NTIS MF A01 CSCL 03B

# 99 GENERAL

**N88-11627#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
**ON THE OCCASION OF THE 50TH ANNIVERSARY OF THE DEATH OF PROFESSOR HUGO JUNKERS [ZUM 50. TODESTAG VON PROFESSOR HUGO JUNKERS]**
Ludwig Boelkow, K. vonGersdorff, ed., and H. J. Ebert, ed. 1987 37 p In GERMAN
(MBB-LW3016/S/PUB/201; ETN-87-90578) Avail: NTIS HC A03/MF A01

The scientific and technical accomplishments of Professor Hugo Junkers are summarized. The different crises in his life are depicted. ESA

## Typical Subject Index Listing

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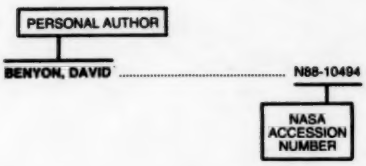


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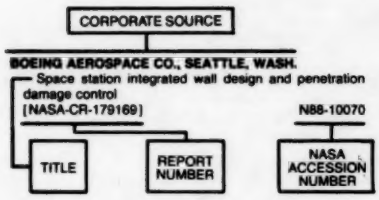


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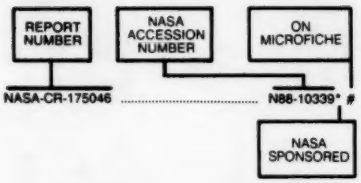


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